# CHEMICAL & METALLURGICAL ENGINEERING

New York, N. Y., Aug. 11, 1920 McGraw-Hill Co., Inc. Vol. XXIII, No. 6, 25c. a copy

"HURRICANE" TUNNEL TRUCK DRYER — Drying High Tension Electrical Insulators. One of the largest installations of its kind in the country.

## "HURRICANE" DRYERS—

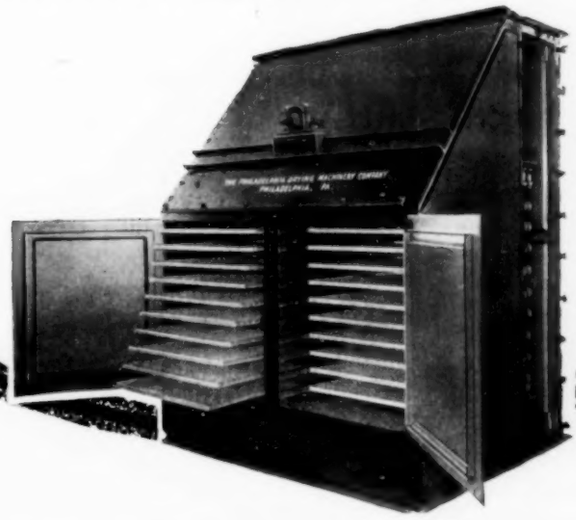
### The Solution for Your Drying Problems

"HURRICANE" DRYERS have successfully tackled all kinds of drying problems in the following industries: Paint, Dyes, Chemicals, Food Products, Textiles, Porcelain, Potteries, Spark Plugs, Storage Batteries, Abrasives, Electrical Porcelain, etc.

You can not find the best solution of *your* drying problems until you investigate what the various types of "HURRICANE" DRYERS can do for you.

**SEE THEM AT THE CHEMICAL EXPOSITION**

**Philadelphia Drying Machinery Co., Phila., Pa.**



"HURRICANE" CABINET TRAY DRYER—for drying small quantities of all kinds of materials. Rapid, efficient, labor and time-saving.

# "HURRICANE" DRYERS

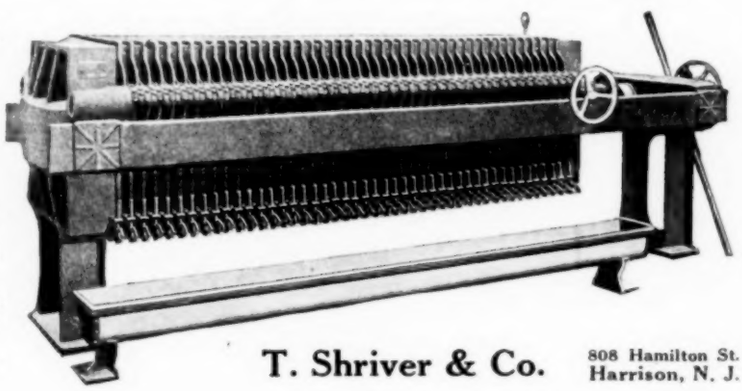
## For Big Production and Low Operating Cost

# SHRIVER FILTER PRESSES

They increase output and effect marked savings in filter cloth replacements and the recovery of values. Little attendance and less wash water adds to their economy.

Have wide joint surfaces. Accurate finishing of plates and frames, coupled with an efficient tightening device, prevents leakage.

Presses for all industrial filtration. Small presses for laboratory work.



**T. Shriver & Co.** 808 Hamilton St. Harrison, N. J.

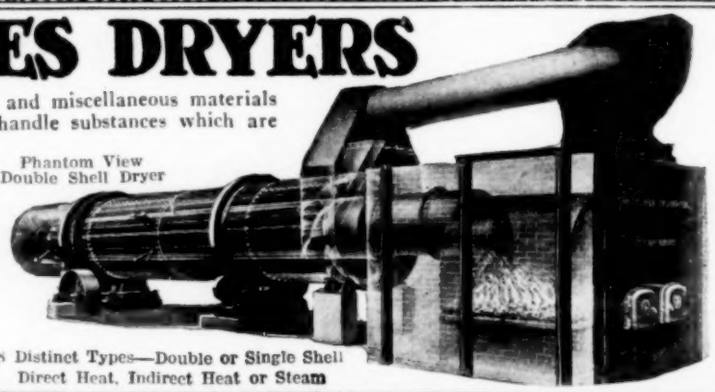
# RUGGLES-COLES DRYERS

are specially adapted to the drying of chemicals and miscellaneous materials because of their ability to withstand and safely handle substances which are corrosive to metals, poisonous or explosive.

Materials requiring temperature as low as 110° F. and as high as 2500° F. can be rapidly and uniformly dried at the lowest possible cost.

***Ruggles-Coles Dryers permit rapid extraction at all temperatures; are highly efficient and easy to operate. Write for further data.***

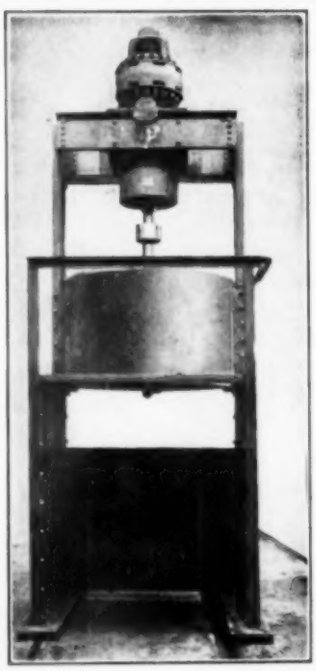
**Ruggles-Coles Eng. Co.**
50 Church St., New York City
Works: York, Pa.



Phantom View Double Shell Dryer

8 Distinct Types—Double or Single Shell Direct Heat, Indirect Heat or Steam

# CHEMICAL CENTRIFUGALS



## The Most Powerful and Efficient Centrifugal for Drying Chemicals!

# "Hercules—Weston"

**Direct Motor Driven** **Self-Balancing** **Bottom Discharge**

Belts, for driving centrifugals, especially in chemical work, are expensive to maintain and, with their necessary guide pulleys, consume power and require attention.

Spindle bearings under the basket are difficult to get at for renewal, putting your centrifugal out of service longer than necessary.

"Hercules-Weston" self-balancing direct motor driven centrifugals use neither belts nor bearings below the basket, and the motor is placed above centrifugal, where it is free of acid and water.

**Sizes 30—36—40—42—48—54 and 60 Inch**
***Manufacturers of Hercules Self-Balancing Hydro Extractors***

*See our exhibit at the Sixth National Exposition of Chemical Industries, Grand Central Palace, New York City, September 20, 1920.*

**EAST JERSEY PIPE CO.** -SUCCESSORS TO- **PATERSON N.J. GILLESPIE MOTOR CO.**

# CHEMICAL & METALLURGICAL ENGINEERING

*A consolidation of*
ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE



H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor
WALLACE SAVAGE
ALAN G. WIKOFF
Assistant Editors

L. W. CHAPMAN
Western Editor
CHESTER H. JONES
CHARLES A. BLATCHLEY
Industrial Editors
J. S. NEGRU
Managing Editor



*Volume* 23 — New York, August 11, 1920 — *Number* 6


## New Application of Minerals Separation Denied

VARIOUS opinions and orders in the flotation litigation have been coming in such rapid succession in the last few months as to have been quite bewildering even to those who are well versed in the subject. Judge MORRIS, however, in the United States District Court, Wilmington, Del., seems to hold the record for his quick response to an unexpectedly rapid move on the part of Minerals Separation in making a new application in less than two weeks after he had denied its first petition to have Miami Copper Co. punished for contempt of court, as reported in our issue for July 21.

For a judge to hear an argument in a case on Monday and render his decision on Thursday of the same week can indicate but one thing: that he looked upon the point at issue simply as a matter of principle which is so clear that "he who runs may read." It might also be interpreted as a rebuke to the petitioner for its obvious failure to accept the court's first denial. Minerals Separation has not been particularly obtuse in its conduct of the flotation litigation, but in this case it seems to have been necessary for the Judge to speak twice in order to be understood. Judge MORRIS' opinion dismissing the latest in the line of Minerals Separation's appeals is published elsewhere in this issue.

## Concealing Patentable Ideas Restricts Mental Development

"WHAT'S the use?" asks the aspiring chemist. "If I do work out a new idea the large corporations have the money and the lawyers will only beat me out in the courts."

So far as ordinary investigation and observation will disclose the truth this opinion, though rather widely held, is without foundation. Specific instances are never cited. Reputable business concerns cannot afford to practice sharp dealing. It is cheaper for them properly to reimburse the inventor. Only the smaller manufacturer or more frequently individual pirates dishonestly seek to profit by the original work of the other man.

The greatest handicap of the average inventor is his own attitude toward the discovery. He becomes possessed of an insufferable egotism which deafens him to all argument concerning the commercial value of the invention, causes him to magnify thousands of dollars into millions and become suspicious of all men. Business of today is carried on through confidence in the other fellow, therefore he believes the chance for him to make a successful bargain is small. He hides the idea away and it becomes lost to industry or is superseded by a better one.

It is deplorable that he cannot have the commercial vision; that he cannot realize the long and costly interval between the laboratory and the manufactured project and finally the expensive advertising and large sales organization necessary to get this product in the hands of the consumer.

How much wiser he would be to sell the idea for a reasonable figure and go out after more ideas—for the world is large and the possibilities for originality of thought are limitless. Large-scale production of new ideas at fair prices will net greater returns than restriction of output of the individual thought factory.

## The Passing of An Industrial Age

IN THIS period of industry we find a comparative few who enjoy the inspiration which comes from creating new things. The craftsman of a few score years ago could look upon the work of his own hands and feel the thrill that comes with individual accomplishment. The completion of the simple machine, the driving of the last nail into the humble dwelling, or the production of an exceptionally good batch of material in the factory, brought to the worker a pleasure that took little count of pecuniary return and still less care for the working hours. Everyone was permitted to enjoy the art of working and the return therefrom was sufficient for the needs of each worker. The greater pleasure of working was predominant as compared to the present-day pleasure of wasting.

Today is the age of superdevelopment of industries when such compensation comes only to the few as represented in founders of new business enterprises, builders and operators of industrial establishments, organizers of large combinations, engineers in new undertakings, and research chemists. The majority of men in the engineering profession are particularly fortunate in this regard, but the masses of men who produce the materials that make up our wonderful fabric of industries are losing the art of working.

We are disposed to become overboastful of our marvelous achievements in quantity production, which is not to our credit, for if we fail to develop the human element there will be little satisfaction in producing the material things which may easily disappear beneath the dust of a few centuries. How little information we really have on the buried industrial monuments of the past! Engineers know that metals corrode and silicates crumble, while philosophers tell us the human soul involves a something that can never perish.

The moral is not that we should forego the comforts, now thought of as necessities, with which we surround ourselves, but that the leaders of finance and industry must pause to consider the eventual evolution of business methods which will create a forward-looking spirit in the heart of each worker. Progress may not then be so rapid but it will be infinitely more sound.

### Electric Furnace Steel On the Pacific Coast

PRACTICALLY all of the iron and steel used on the Pacific Coast either is produced locally from scrap or is purchased in the East. The cost in either case is about the same. In addition to the high price, the supply from the Eastern markets is subject to uncertain delivery due to transportation difficulties. These two factors, among others, are reviving interest in the establishment of an iron and steel industry on the Coast; and as it is doubtful whether there exists at the present time a market demand large enough to warrant the establishment of a full-sized standardized steel plant using blast furnaces for the production of pig iron, the possibility of using the electric furnace is being considered. It is argued that steel is being produced successfully in Sweden in electric furnaces. If there, why not here? And steel is steel.

There are obvious reasons why the electric steel industry of Sweden is successful. Power is cheap, as low as $10 per horsepower-year. Charcoal is available in quantity and is also cheap. The iron ores are of unusual purity. The product is of exceptional quality and therefore commands a higher price in the market. The cutlery industry of Sheffield, for instance, is largely dependent on Swedish iron, and there is in addition a wide demand for this product which practically assures a stable market for Swedish iron regardless—within reason—of the conditions in the general iron and steel industry. But similar conditions do not exist on the Pacific Coast.

If an electric steel industry is to be established there the output must compete with ordinary grades of iron and steel, at least until a local demand is created for electric-furnace products. There are, however, conditions which seem to warrant an undertaking of this kind. There is a potential market for steel products in the Orient. This is large, but it would have to be developed. The local demand is good and economic influences are evidently tending to increase general manufacturing on the Coast, and this would naturally increase the demand for iron and steel. There is then a permanent and growing local market together with possibilities for export trade, and steel products will continue to command a higher price in the West than in the East.

Other influences which are tending to arouse interest in the use of electric power for the production of iron are the publicity recently given to the Fleet process and the economies claimed for it, together with the fact that a good grade of foundry iron has been made in an electric furnace from magnetite iron ores. The present production of electric-furnace foundry-pig is small, but because it is of a better grade than that which can now be purchased in the open market, it commands a high price, particularly for the manufacture of pistons for automobile engines and similar uses. The demand is limited, however, and cannot be indefinitely extended. The Fleet furnace is an adaptation of the open-top pit-furnace, such as has been used for the production of ferro-alloys, but air is blown into the charge below the electrodes. There may be conditions under which this would not be fatal to the life of the electrodes, but it looks wrong economically.

The arguments mentioned above are modified to suit local conditions, but boiled down are two: "It is being done," or So-and-So "claims it can be done." Fortunately, the promotion is not being conducted in a large way as yet, although this will not be of much consolation to those who may lose thereby. It is regrettable, nevertheless, that these undertakings are being started when they lack sufficient capital and are poorly supervised technically. If able technical skill be obtained and this be backed by adequate capital, there seems no reason why electric-furnace reduction of iron ores should not prove a profitable undertaking. Certainly it is a necessary economic development.

### Interchurch World Movement On the Steel Strike

THE "Interchurch World Movement" was already discredited in many quarters before the appearance recently of the report of its commission on the iron and steel strike that began Sept. 22, 1919, and this report serves further to discredit the management of that curious organization. There is in the report a strong and obvious bias against the iron and steel manufacturers, and particularly the United States Steel Corporation, a bias that is, indeed, paraded by pages of invective and innuendo. This, however, was to have been expected when during the so-called "investigation" the paid investigators picked out their witnesses with an evident determination to obtain the kind of evidence they had set out to get.

The report claims that FOSTER recanted the syndicalist teachings in his earlier book and that he conducted merely an old fashioned strike, but, strange to say, FOSTER'S new book, "The Great Steel Strike and Its Lessons," says that "the trade unions are by their make-up and methods anti-capitalistic."

FOSTER preserves his views and tries to write himself into the trade union ranks, for which the trade unionists will return him no thanks. By a different line of approach the report of the Interchurch World Movement seeks to do the same thing.

The report minimizes, almost completely ignores, the great amount of improvement there has been in iron and steel labor conditions in recent years, though the improvement reflects very great credit upon the manufacturers, and certainly no less upon the Steel Corporation than upon the independents, whereas the Steel Corporation is picked out in the report for particularly venomous attack.

Practically throughout the report one can see traces of a belief that the desired improvement in iron and steel labor conditions can be obtained only by unionism, and this is an egregious blunder. The present co-operative spirit, through which so much already has been attained, cannot exist when there is trade union control, or at least it does not exist in cases where there is such control. To establish trade unionism in the iron and steel industry would be to tear down what has been done. The Steel Corporation's recently adopted plan, by which any one of its employees is enabled to own his home by finding in cash 10 per cent of its cost, would have to go by the board, for trade unions as we know them do not countenance such things.

One naturally asks why the report should lean so toward trade unionism as the remedy for conditions of which complaint is made when the practical experience of industrial America is that approximately 90 per cent of the workers are non-union and approximately 10 per cent are union. That the proportions are substantially as stated can be shown by citation of statistics that are accessible and quite easy of analysis. Even if the union

proportion were double that just stated, there would be a four-to-one shot against unionism. In this age of enlightenment there must be a reason for the proportion. It is not an accident, a chance. Nor can it be a chance that since the effects of the recent strike wore off the iron and steel industry has been fairly well manned, with no labor shortage and with the labor showing greater efficiency than is reported for many other industries, and all this in a time when the country has in general a shortage of labor. The practical test shows that conditions in the iron and steel industry are not bad, but rather are relatively good.

## Co-ordinating Research, Development and Accomplishment

THERE is a wide gap between the research laboratory and the plant, as all practical plant managers who have tried to bridge this space are well aware. The Bureau of Chemistry in Washington is taking a splendid step forward in its effort to make less difficult this passage from the laboratory to practical industrial affairs. Dr. ALSBERG, Chief of the Bureau, has just announced the formation of a development section within the Bureau. This section will be charged with bringing together the successful research results and the industrial men who can probably make use of the laboratory conclusions. It is hoped that thereby much of the productive work of the Bureau that hitherto has gone without deserved attention can be made promptly useful in our commercial life.

The Bureau of Chemistry has been responsible for much successful work. The new method for manufacture of phthalic anhydride which it developed has been a powerful factor in placing our artificial indigo in successful competition with the foreign product. The grain-dust-explosion studies have doubtless been the most important factor in the wonderful success attained by the United States Grain Corporation in protecting cereal foodstuffs during the war period. However, there have been other equally promising but less successfully applied results, many of which doubtless could have been "put across" if it had been possible to tie up the research conclusions with the right industrial organization. Research by itself has little industrial value, but its application through proper development affords tremendous possibilities.

## Chasing Rainbows In Leisure Hours

> The power which resides in him is new in nature, and none but he knows what that is which he can do, nor does he know until he has tried.—*Emerson.*

TAKE the case of the average laboratory or office worker. Confined within four walls during the hours allotted to labor, he may perform the tasks assigned to him well enough. The work may even hold a certain immediate interest for him, and hazy thoughts of future achievements flash through the inner consciousness. When the day is done he engages in a chosen recreation and finally goes home and to bed. Next day he arises to repeat the operation and so on through the years—routine, recreation, bed.

He fails to rise to the place awaiting him in the economic scheme because he only partly expresses through his works the particular things that nature has placed within him. He overlooks the hazy thoughts. He classifies them as rainbows and does nothing. Consequently there is no development of thinking ability and it eventually dies from lack of exercise. So we wrongly connect rainbows with youth and attribute lack of imagination to old age.

He who loves chemistry, on the contrary, will snatch his needed exercise in the early morning, carry on the bread-winning job with a vim and return home to work through the evening hours at his own little laboratory bench in attic or basement; to chase down the rainbow flashes of the day for a final solution. Often the results may be negative, in which case he has profited by learning. But there are "pots of gold" at the end of many rainbows and by continual application the chemist cannot fail to win them. The law of averages is with the worker.

Several of our most noted chemists can attest to the direct returns derived by chasing rainbows in the hours off duty. One expresses it by the homely saying, "Graft a tail on your dog, and the tail will eventually wag the dog."

## Archaic Attitude of Chemical Business Men

ACCORDING to the creed of the old alchemists, their secrets were too precious to be revealed to baser men. The reverence paid to this tradition on the part of business men in the chemically controlled industries has restricted progress even to the present time. CHAUCER writes:

> The Philosophers were y-sworne eche one
> That they shulde discover it unto none,
> He in no boke write in no manere
> For unto Christ it is so lefe and deare:
> That he wol not that it discovered be,
> But where it liketh to his deite:
> Man to inspire and eke for to defend
> Whan that him liketh; in this is his end.

The policy of secrecy instituted by the directors of some of our largest chemical companies does not succeed in keeping the information, with which they suppose themselves blessed, from those who want to obtain it for business competition, but simply prevents much needed publicity for the enlightenment of laymen. Many of these processes are discovered to competitors through the same methods employed in originally securing the data from foreign manufacturers.

In proportion as the public remains uninformed, so the lack of knowledge reacts against the industry. The attitude of the courts in holding that the art is still in the state of alchemy is an illustration and fairly representative of the lay idea. The tanning and clay industries have long suffered lack of progress through the custom of "death-bed secrets." Certain groups of manufacturers of dyes, organic chemicals and nitrates are inconvenienced through slow legislation, caused primarily because the business has been presented with so much mystery in the past that the lawmakers lack confidence in scientific testimony. Consumption of chemicals might be increased many fold if the buyers were thoroughly advised as to the antecedents. The chance to hocus-pocus the American public with pharmaceutical nostrums grows less each year.

Let us be frank about it—secrets are of short duration among members of the chemical profession. It is better to lay the facts openly before the public than to have them leak out to the confusion of all, with consequent reaction on the manufacturer.

# Readers' Views and Comments

## The Commercial Development of Fused Silica

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—Our attention has been drawn to an article in your issue of March 31 by John Scharl and Wallace Savage entitled "The Commercial Development of Fused Silica," and as reference has been made to our company, we desire to put on record the following statement of facts:

Prior to the date of the patents of Bottomley, Hutton and Paget, and Bottomley and Paget,[1] which have been assigned to and worked by this company, there was no process whatsoever for fusing quartz or silica, and shaping it while still in a plastic condition without reheating. Confirmation of this is to be found in the judgment delivered by the German Supreme Court at Leipzig in 1913, in an action brought by the Deutsche Quarz Gesellschaft and others for the annulment of the German patents which correspond to the British patents owned by the Thermal Syndicate. The judgment which confirmed in full the validity of the patents is given *in extenso* in *Zeitschrift für Elektrochemie*, 1913, No. 19. We quote the following translation:

> The process rests on the surprising fact, new for the experts of that time, that the fused quartz mass can be removed from the furnace in a plastic condition and immediately brought to the desired shape by drawing and blowing. Until then this was held to be impossible on account of the viscosity and quick cooling. The fused mass was therefore always allowed to cool and solidify before steps were taken to work it further in the oxy-hydrogen blowpipe flame . . .
>
> The annulment of these three claims is so much the less justified since by this process, as the plaintiff does not dispute in principle, decided industrial progress has been made in that it opened the possibility of producing cheaply and on a manufacturing scale, refractory vessels specially resistant toward changes of temperature of all kinds and shapes for the large chemical industry and especially for the manufacture of sulphuric acid.

It is true that the Deutsche Quarz Gesellschaft, which was formed by Dr. Voelker, commenced to manufacture fused silica at Beuel on the Rhine, but the process it used was practically identical with and wholly subsidiary to the patent of Bottomley and Paget, and in 1911 our company found it necessary to institute proceedings against Silica Ware Limited, which had been selling the manufactures of the Deutsche Quarz Gesellschaft in England.

This suit was tried before Mr. Justice Eady sitting in the Chancery Division of the High Court of Justice and resulted in a judgment sustaining the validity of the British letters patent No. 18,437 of 1904, granted to James Francis Bottomley and Arthur Paget, and finding infringement and granting an injunction against the defendant. The Court said in its decision:

> In my opinion the specification fully describes the nature of the invention, which is a very important one, and it gives a complete and accurate description of at least one method of carrying it into effect. In my judgment the patent is a valid one and the defendants have infringed it and the plaintiffs are entitled to the usual relief with costs.

THE THERMAL SYNDICATE, LTD.
Wallsend-on-Tyne, England. By J. Frank Bottomley.

[1]English Patents 10,670 and 18,434 (1904). U. S. Patents 812,399, 822,424, 936,558 and R. I. 13,504 (1906).

## Elastic Development of Steel

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—It has occurred to me that some criticisms regarding a paper on "The Elastic Development of Steel" by Sidney Cornell in CHEMICAL AND METALLURGICAL ENGINEERING for April 14, 1920, may be useful.

Such statements as given in paragraph 3 of the article concerning the relation between hardness, strength and heat treatment would require extensive investigation to prove and certainly are not justified by his data. If he has noted any real increase of hardness with higher drawing temperature in the bayonet steel (which I doubt), the effect could be attributed to the chromium content of this steel and would be analogous to "secondary hardening" in tool steels containing chromium.

On page 678, under "Standardized Heat-Treatment," it is stated that bayonets were heated for 4 min. in a lead bath for "hardening" and 3 min. and 2½ min. for drawing. Obviously four minutes is not time enough for the transformation which produces hardening to complete itself and is well borne out by the curves given, assuming that a similar time element was used for obtaining the data for Figs. 2, 4 and 7. With proper length of time for hardening the maximum hardness should be obtained by quenching from about 50 deg. F. above the critical point; higher temperatures would then give less hardness. If the time element is not great enough, however, it is necessary to increase the temperature proportionately such that the transformation can complete itself in the short time allowed. Thus in Fig. 4 a temperature of 2,000 deg. F., about 500 deg. F. above the critical point, has been required, whereas with a normal time, say 15 min., 1,525 deg. F. would probably have produced the maximum hardness.

In making tensile tests of hardened steels with little or no tempering it is practically impossible without taking extreme precautions and using the best of apparatus to obtain the true value of the tensile strength and other properties. These values will generally be too low due to the specimen breaking prematurely partly because of unavoidable non-uniform axial loading of the specimen. As soon as the drawing temperatures are high enough to give the material some ductility, the specimen will yield under the non-uniform loading and normal tensile values will be obtained, which will be higher than those obtained for the more brittle material. This phenomenon will easily account for the so-called "elastic development" in Figs. 6 and 7. In fact, the coincidence of the "elastic limit" and the ultimate strength up to 750 deg. F. in Fig. 9 points to such a condition having existed.

In many of the diagrams the author combines scleroscope and Brinell hardness on the same co-ordinate. Since no definite relationship has been established between these two indices for all classes of steel this practice is somewhat questionable.

In this paper the term "elastic limit" is incorrectly used. The accepted definition of this term is "that stress which first produces a permanent elongation in

the material," thus necessitating a release of the load, a procedure which is seldom if ever done in commercial testing. Proportional limit or yield point are the terms that generally should be used in place of elastic limit.

I believe the problem which the author undertook to solve is an excellent example of one where the proper use of the microscope would have greatly expedited the result and aided in prescribing the proper heat treatment.

R. W. WOODWARD.

Washington, D. C.

---

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—In regard to the various criticisms of Mr. Woodward on "Elastic Development of Steel," I would like to answer them as they occur.

The results summarized in paragraph 3 of my original article covered three years' work all told. Possibly the term "maximum tensile strength" is misleading as used in the expression. The greatest elastic limit and incidentally also the maximum tensile strength is not obtainable in steel when hardened only, but is found in the hardened steel when drawn at a more or less closely limited drawing temperature. (Third paragraph.)

Deflection tests made upon heat-treated bars lead to the curves and conclusions noted in the paper in all cases. Bar stock was tested under central loading on a 6-in. span, deflections being noted by gage, and the computed extreme fiber stress at yield point and at failure recorded "Yield Point" and "Ultimate Strength."

The critic used the term "Hardness" in his letter, stating that if any real increase in hardness with higher drawing temperature was noted, the effect would be attributed to secondary hardening. In no instance in the original paper does the statement appear that the hardness (as measured by the Brinell ball test) is increased by drawing. Maximum Brinell hardness may theoretically be obtained after proper heating at a certain temperature above the critical, but in commercial practice an increase in Brinell hardness actually may be noted when properly heated steel is quenched from increasing temperatures, defining the word "properly" as being of the same order as the soaking periods used in industry.

"Hardness" cannot be used to define a useful property of steel. "Toughness" is not exactly adequate, and a term combining the ideas hardness, toughness and elasticity is needed. "Degree of resiliency" certainly increased with the higher drawing temperatures, since a bayonet blade that would set (i.e., take a permanent bow) when oil quenched after 10 min. in lead at 1,530 deg. F. and drawn at 550 deg. F. for 4 min. would not take a permanent set when drawn at 750 deg. F. for 4 min. after quenching from 1,480 deg.

Lead hardening of bayonet blades at 1,500 deg. F. for 4 min., as mentioned in my original paper, might best be elaborated by saying that the bayonet blades actually were preheated to approximately 800 deg. F. in lead, remaining thus for as much as 10 min. before being immersed in the lead at 1,500 deg. F. for 4 min. Time required for transformation is a matter which is far from being adequately studied or understood. Heat transmission commutations from solid to gas or solid to liquid are possible with the somewhat meager data now known, but who knows what are the thermal constants attending recrystallization of steel? The critical point of this bayonet steel was 1,380 deg. F., and with a proper length of time, soaking at the suggested figure of 1,380 deg. + 50 deg., or 1,430 deg. F., undoubtedly would harden the bayonet correctly. The time required is problematical, since chromium steel lags badly in passing through the critical range. My data indicate this to be as much as 60 min. at the critical point itself, but perhaps 11 min. at 1,450 deg. It is agreed that there is a time element entering into all transformations of internal molecular arrangement, but what it is remains to be determined.

The data given in curves 2, 4 and 7 were obtained from specimens of the bar stock, allowed to sojourn in an electric furnace 20 min. after coming to heat. Axial loading is difficult if not impossible to obtain in making tensile tests, and with this in mind elastic development tests were made in bending as prescribed immediately above, such errors not occurring in this practice. Such a series of tests on hardened and drawn bars, always in duplicate, furnishes unmistakable data that the extreme fiber stress at yield (permanent bend on release of load or disproportionate deflection increment to load increment) can be increased with annealing temperatures. I have confirming tests on tension specimens—the fact is independent of the method of testing.

Combination of Brinell and scleroscope should not of course occur in the same diagram, as there is no relation between them for different steels.

Elastic limit and yield point are relatively well understood, yet precise technical phraseology is admitted to be a weakness of all Americans. In all of the tests recorded in the article an Ames indicator taken from an extensometer measured the deflection, and the elastic limit was recorded, not the yield point. But I maintain that even if the yield point were recorded instead of the elastic limit, it would not make any difference whatsoever in the elastic development.

Contrary to Mr. Woodward's assumption, the microscope was extensively used continually from beginning to end of the Remington bayonet job. Where we relied upon the microscope alone, we failed to get the bayonets accepted. Yet in conjunction with a research into the physical properties as developed by carefully controlled heat treatment, success was attained. After all, that was what we were after. While the intricate and apparently bizarre metallographical appearances encountered were given careful and continuous study, they could not be harmonized into a systematic mass which could be used in the routine treatment.

New York City. SIDNEY CORNELL.

---

## Would Platinum Registration Be a Safeguard Against Theft?

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—Your recent editorial on platinum thefts invites expression of views on the subject, and recalls a letter received some time ago from one of the leading platinum refiners and manufacturers in this country. From this I quote:

"We always try to be extremely careful not to purchase anything in the way of platinum scrap from strangers or persons whose business standing is not well known to us, unless our inquiries as to the source of the supply are satisfactorily answered; and in no case do we pay cash over the counter. This has been the position which we have taken from the start in this business, so that a professional thief is not likely to repeat an attempt to dispose of stolen property with us."

This attitude on the part of platinum refiners was the chief safeguard of the chemical laboratories as regards their supply of platinum, for it is obviously difficult and exceedingly inconvenient, especially in college laboratories, to avoid all possibility of theft.

Since the widespread introduction of platinum into jewelry the number of refiners has of course largely increased, but the number of those who are not reputable is certainly very small, and the whole number is not large. Might it not be possible for the jewelers' association through its committee on platinum to keep sufficient track of the platinum received, manufactured and sold to prevent any considerable quantity of stolen platinum being disposed of?

It seems preposterous that there should be a market for the 2,000 oz. of refined platinum sponge recently stolen from the Government and "no questions asked"!

Lexington, Va. JAMES LEWIS HOWE.

## In Support of American Instrument Industry

*To the Editor of Chemical & Metallurgical Engineering*

SIR:—The following bulletin has just been brought to my notice and it emphasizes very clearly the continued activity of the propagandists, although the author may not realize that such statements as he has made in effect afford aid and comfort to those who have been our enemies and, to the best of my information, continue to be our industrial enemies:

SHORTAGE OF MICROSCOPES

American Science Badly Handicapped by Lack of Important Instruments

*By Universal Service*

CHICAGO, June 25.—The United States has had a shortage of sugar, a shortage of flour, a shortage of ships and all kinds of shortages. Now one more shortage has arrived—a shortage of miscroscopes.

The "eye of science," as the microscope is known, is becoming very essential, and a shortage in the instruments will be a serious trouble, for they are used to give the once over to everything from potato bugs to battleships.

The lack of the instruments and their importance in everyday life was recently made known by Dr. V. A. Lamar, recording secretary of the Illinois State Microscopical Society.

"We're going to fall behind as a nation," Dr. Lamar said. "We haven't enough microscopes. Most of our microscopes came from Europe, particularly Germany. Now, with the tax on imported microscopes so high, we are using our own, and they are in the main inferior grades. Inferior work is bound to be done. And inferior microscopic work doesn't mean merely something pertaining to medicine.

"The microscope is used today in nearly every industry. All the great manufacturing plants employ experts. Grain is inspected with it, steel, iron, seed, cloth, insect life.

"It isn't that we haven't the necessary materials for the manufacturing of microscopes that is causing the shortage. A sand deposit has just been found in Michigan which is probably as good as any in Europe, for optical purposes. But we don't recognize the important part played by our microscopical experts. We underpay them. We underpay the men who construct as well as those who use them.

"If we are to advance as a nation, and not fall behind even broken Europe, we must pay more attention to our skilled workmen and not concentrate on our laborers."

The statement I object to is the one in which Dr. Lamar states that the American microscope is inferior to those to be obtained particularly in Germany, and that with such microscopes there is sure to be inferior work in the field of medicine. I agree with him that those who use the microscope are often underpaid, but I have no information as to the present wage scales of those who construct microscopes. It seems to me that one factor in the equation which has been overlooked is the failure on the part of some of those who use microscopes adequately to support the American scientific instrument industry, and lacking such encouragement, it is not surprising that the industry does not do all that might be wished.

I presume Dr. Lamar has in mind apochromatic objectives and compensating oculars. Before the war the great majority of these objectives were used by those who could and did import free of duty. The total business in dollars and cents is small and there was no incentive for American manufacturers to develop extensively this class of optics under those circumstances. There have always been men in our country who refuse to buy American-made microscopes and I personally have dealt with many such in the days when I endeavored to sell microscopes. Several of these men have since been won over to the American products by the improvements which have been put into them. Today American microscopes are selling in all parts of the world, including Europe, and I feel confident that it can be shown that American microscopes are equal to the burdens placed upon them.

I do not have the pleasure of knowing Dr. Lamar, but I feel sure he has lost sight of the execellent progress made by the manufacturers of American scientific instruments and failed to give them the desired encouragement, when he speaks of the liability of inferior work in science and the arts if we must depend on American apparatus. As he says in his last paragraph, we must pay more attention to our skilled workmen, but to decry American goods made by such workmen does not seem the best way. HARRISON E. HOWE.

Washington, D. C.

## Dome Covers of Empty Tank Cars Should Be Made Secure

To emphasize the importance of complying with the regulations of the Bureau of Explosives of the United States and Canada, which provide that dome covers of tank cars be securely placed in proper position and that placards reading "Inflammable" be placed prominently on empty tank cars, B. W. Dunn, chief inspector of that bureau, has called the attention of the National Safety Council to a recent accident caused by violation of this regulation which resulted in the death of one boy and the serious injury of another.

Boys playing on an "empty" tank car removed the insecurely fastened dome cover. One boy entered the tank and struck a match. The vapor was ignited and the explosion hurled the boy's body out of the tank to the top of a box car, causing his death.

The report of the Bureau of Explosives says: "If the refining company which last unloaded this tank car had properly tightened the dome cover, it would not have been possible for the boys easily to unscrew same."

On the other hand, it is known that tank car dome covers in that particular section of the country are occasionally tampered with by persons seeking alcohol. This brings us to rule 1872 (B) which reads:

"Unauthorized persons must not be allowed to have access to explosives or other dangerous articles at any time while such articles are in the custody of the carrier."—*International Safety News.*

# The Electrolytic Zinc Plant of the Consolidated Mining & Smelting Co. of Canada, Ltd.

**At Trail, B. C., the Solution for Electrodeposition of Zinc Is Prepared by Treating the Calcined Concentrates With a Neutral Leach, Followed by an Acid Leach—Construction Details of Tank Room, Cells, Busbars, Anodes and Cathodes**

By L. W. CHAPMAN

ELECTROLYTIC zinc, the first to be marketed in America, was produced in a 1-ton experimental plant of the Consolidated Mining & Smelting Co. of Canada, located at Trail, B. C. Since the first commercial electrolytic zinc was produced early in 1914 the company's product has been continuously on the market, but is now produced from a very efficient 75-ton plant, and slab zinc is being made at a cost permitting a reasonable profit at the present market prices, a fact which effectively disposes of the economic aspects of the electrolytic method of producing this metal. The metallurgical plant at Trail is interesting as a whole, the electrolytic zinc plant being but one department; there is, in addition, an electrolytic copper, a Betts electrolytic lead refinery, a copper and a lead smelter and plants for the production of sulphuric, hydrofluoric and hydrofluosilicic acids. The slimes from the lead and copper refineries are cupelled and parted, and the silver and gold are shipped as refined metal. Custom ores are purchased containing gold, silver, copper, lead and zinc, but until recently the company has depended almost entirely on the ores from its Sullivan mine at Kimberly, B. C., to supply the electrolytic zinc plant.

The present electrolytic zinc plant was built during 1915 and the first zinc was produced in February, 1916. The plant as originally designed had a capacity of about thirty tons of zinc per day, but was enlarged to its present capacity by adding a second tank room, the necessary additional equipment to the leaching plant and six motor-generator sets.

The ore is received at the concentrator in standard steel bottom-dump railroad cars and is concentrated by flotation and magnetic processes, the concentrates being delivered to the zinc plant. The concentrate contains zinc, lead and iron as sulphides and in order to render the zinc soluble in sulphuric acid is roasted in thirteen standard seven-hearth 25-ft. Wedge roasters at a maximum temperature of about 700 deg. C. The roasters are fired on either the fifth or sixth hearth by two coal-fired combustion chambers located at opposite ends of a diameter of the furnace. The roasters have a capacity of about forty tons dry ore per day. A calcine is obtained of the following average analysis: Ag 2.8 oz. per ton, Cu 0.03 per cent, Pb 11.1 per cent, Zn 27.0 per cent, Fe 25.8 per cent, CuO 1.8 per cent and Mn 0.9 per cent. The roasting of concentrates high in iron presents many difficulties. It is essential that a maximum amount of the iron in the concentrates be oxidized to the ferric condition, otherwise it would be impossible to obtain a complete precipitation of the iron or the complete removal of the arsenic and antimony simultaneously with the iron; a result which is obtained when the pulp is neutralized in the leaching operation. sulphate in the calcium to avoid the necessity of adding sulphuric acid to the solutions, and an excess of sulphuric acid must be avoided. This is approximately 3 per cent as sulphate.

## Leaching Plant

The leaching of the zinc from the calcine by a cyclic use of acid solution is conducted in two stages termed the "neutral" and the "acid leach." The primary object of the "neutral leach" is to bring about the complete precipitation of the iron and to neutralize the free acid in the solution by means of the basic constituents of the roasted concentrate. The primary object of the "acid leach" is to remove the maximum amount of the soluble zinc remaining in the pulp after the "neutral leach" and thus produce a plant tailing low in zinc. The solution obtained from the neutral leaching operation is purified by precipitating, by means of zinc dust, the metals in solution electro-negative to zinc. The solution is then electrolyzed, the zinc being deposited on aluminum cathodes and an equivalent amount of sulphuric acid liberated at the anodes. Eighty per cent of the solution from the electrolytic cells is used in the "acid leach." The remainder, together with the tailing solution from the acid leach, is used in the "neutral leach." All the calcine is first treated in the "neutral leach," and the pulp is thickened and treated in the "acid leach." The flow sheet indicates diagrammatically the steps in the process, the solution following the heavy lines and the solids the light lines. The apparatus used in the "acid" leaching step is indicated by *A*, in the "neutral" leaching step by *N*, in the purifying step by *P* and in washing the plant tailings by *W*.

## The "Neutral Leach"

The essential requirement for efficient deposition of zinc by electrolysis is a pure solution. This means a solution in which the amount of deleterious impurities does not exceed the limits that have been established for efficient tank room operation. The solution may be, and usually is, saturated with the sulphates of the alkaline earths, but the quantities of metals electro-negative to zinc that are permissible are as a rule less than a milligram per liter. This purification, to be described under that heading, is accomplished in a neutral solution. In the plant fresh roasted concentrates are used for the neutralization of the acid. All of the calcine from the roasters is fed into the first of a series of four 10 x 30-ft. Pachuca agitation tanks and into this tank is also run the tailing solution from the "acid leach" and about 20 per cent of the acid electrolyte or tailing solution from the electroytic cells. In addition a certain amount of manganese dioxide is

added to assure the complete oxidation of the iron. A controlled amount of pulp from the first agitation Pachuca is bypassed to the second, and the pulp is advanced through the third and the fourth tanks in similar manner, the overflow from the last tank being divided into two portions, each flowing to a pair of 15-ft. Dorr classifiers in series, the sand from the first Dorrs being reclassified in the second. The overflow from the Dorr classifiers flows to a 40-ft. Dorr thickener and the sand from the classifiers is delivered by centrifugal pumps to the "acid" Pachuca. A 40-ft. Dorr thickener receives the pulp from the classifiers and acts as a distributing tank, the overflow being delivered to four 40-ft. and three 32-ft. Dorr thickeners. The spigot product of the eight thickeners flows by launders and pumps to the "acid leach," and the overflow

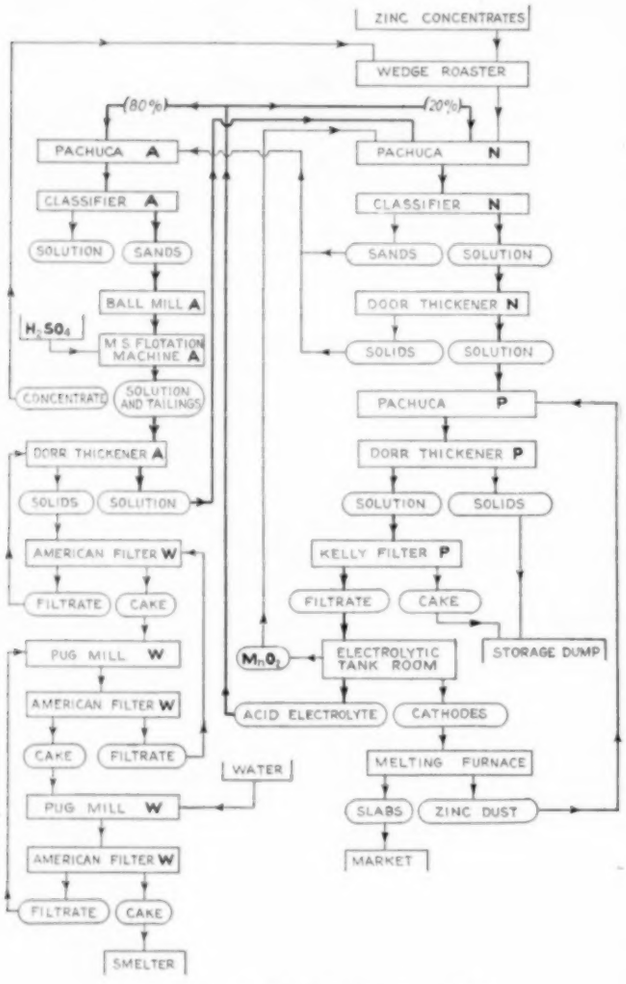



FIG. 1. FLOW SHEET OF PLANT

from the seven outer thickeners is combined and delivered to the "purification" Pachucas.

There are three important functions performed in the neutral leaching operation:

First, the complete oxidization of the iron by the manganese dioxide and the complete precipitation of the iron by the basic constituents of the calcine. The soluble arsenic and antimony is also almost completely removed from solution as compounds of iron.

The step is, then, an important one from the point of view of purification, all three of these impurities being extremely detrimental to efficient tank room operation.

Second, the acid in the solution is neutralized by the zinc oxide in the calcine, thus bringing about the solution of a portion of the zinc. This neutralization makes possible effective purification in subsequent operations as noted before.

Third, a degree of flocculation of the colloids in the solution is attained which makes possible the settlement of these solids and their efficient removal.

### The "Acid Leach"

The sands from the neutral classifiers and the spigot product from the neutral Dorr thickeners are delivered to the first of the four 10 x 30-ft. agitation Pachucas in which the "acid leach" is conducted. To the tank is added about 80 per cent of the acid electrolyte, and the pulp is advanced through the series of tanks in the same manner as in the "neutral leach." The overflow from the fourth tank is divided into two portions as in the "neutral leach" and delivered to a pair of 15-ft. Dorr classifiers in series, the sands from the first classifier being reclassified in the second. The sands are fed to a 6 x 6-ft. ball mill, and the ball mill product, together with the overflow from the classifier, is divided into two portions, each portion being fed to a standard 8-cell M. S. flotation machine. The overflow from the last cell of the M. S. machine contains about 0.2 per cent free $H_2SO_4$. About thirty-five tons of zinc concentrate containing approximately 41 per cent zinc is produced per day, which is filtered on a 12 x 12-ft. Oliver filter and returned to one of the 25-ft. Wedge roasters. As previously stated, the roasting of a zinc ore high in iron is attended with many difficulties due to the necessity of effecting a practically complete oxidization of the iron. A certain amount of zinc sulphide remains unaffected and thus makes necessary its recovery by flotation.

The tailings from the M. S. machine and the filtrate from the Oliver are distributed to seven 40-ft. Dorr thickeners, the pulp flow to these being in parallel. The acid overflow from these thickeners is pumped to the first neutral agitating tank or Pachuca as noted before.

### Washing the Tailings

It is necessary to remove the soluble zinc from the spigot product from the acid Dorr thickeners, this operation being performed by three American filters and two pug-mills in series. The pulp is first filtered on an American filter (having eight 6-ft. disks). The filtrate is returned to the feed-launder of the Dorr thickeners. The cake from this filter is pulped in a pug-mill with the filtrate from the third filter and the pulp filtered on a second American filter. The filtrate from this filter is added to the feed to the first filter and the cake is pulped in a second pug-mill with water. This pulp is filtered on the third filter, the filtrate going to the first pug-mill as noted. The cake from the final filter is dried and smelted for the recovery of the lead and silver.

### Purification of the Zinc Solution

The course of the solids has been followed through the leaching plant and that of the solution as far as the purification. The neutral overflow from the neutral Dorr thickeners is pumped to the first of three 8 x 20-ft. Pachucas. An amount of zinc dust sufficient to precipitate the copper, cadmium and remaining traces of arsenic and antimony is also added to the first tank.

The flow of the solution and zinc dust through these tanks is in series and from the third Pachuca the product flows to a 23-ft. Dorr thickener. The overflow from the Dorr is filtered in seven Kelly filters and the filtrate pumped to storage tanks which supply the tank room with neutral purified solution. The filter cake and spigot product from the Dorr thickener is delivered to a storage dump. The purified solution contains about 60 g.p.l. Zn, 0.02 g.p.l. Fe, 0.0005 g.p.l. Cu.

## Electrolytic Tank Rooms

The plant was originally designed to produce from thirty to thirty-five tons of electrolytic zinc per day and the first or No. 1 tank room contains 448 cells arranged in fourteen sections of thirty-two tanks each. When the capacity of the plant was increased to seventy-five tons per day, a second tank room was built containing 384 tanks (twelve sections), but in other respects the two tank rooms are similar.

The following description is of No. 2 tank room and equipment:

As stated, the No. 2 tank room contains 384 tanks, arranged in twenty-four parallel rows of eight double tanks to the row, the tanks in each row being arranged in cascade. Between the rows of tanks there are 30-in. aisles. At the lower end of the room is a floor space about 20 ft. in width; the stripping of the cathodes is performed on this floor and the sheets are loaded on to trucks running on narrow-gage tracks which convey the cathode sheets to the melting furnaces located in an adjacent building.

Each tank has a longitudinal partition dividing it into two cells. The tanks are made of concrete reinforced at all corners and bottom with chicken-wire-mesh wire reinforcing. The walls and bottom are 4 in. in

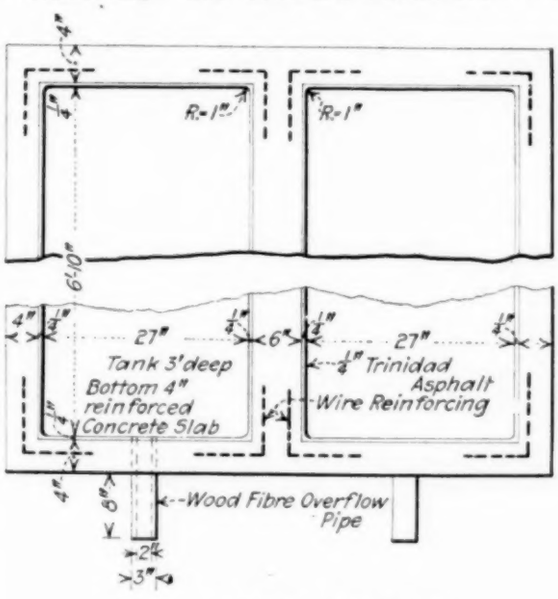



FIG. 2. PLAN OF AGGREGATE

thickness and the partition 6 in. The sides and bottom are lined with Trinidad ashphalt ¼ in. in thickness and the outside of the tank is painted with asphalt paint. The interior dimensions of each cell, of which there are two to a tank, are 27 in. wide x 82 in. long x 36 in. deep. There is a 4-in. space between tanks. Overflow of electrolyte from one cell to the next lower in the cascade is through a length of 2-in. wood-fiber pipe, the difference of elevation of the tanks being 4 in. The tanks are supported on concrete piers and are insulated from the piers by means of porcelain blocks.

At the inlet end of the tanks and parallel to the end there is inserted a wooden baffle which extends to within 10 in. of the bottom. This causes the electrolyte to flow down within the space thus formed, within which is placed a cooling coil containing 30 ft. of 1-in. chemical lead pipe. Ten of these coils are provided for the eight cells in the cascade, the two middle cells having two coils each, one located at each end. The cooling water flows through the coils in the four upper cells

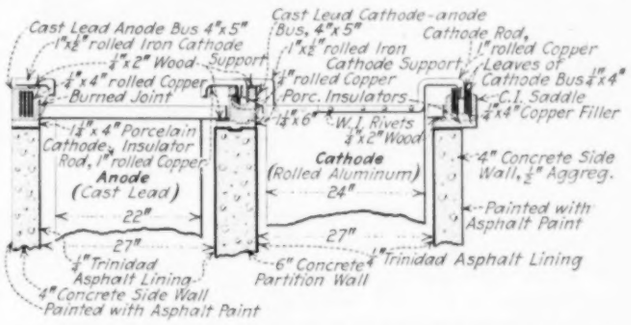



FIG. 3. SKETCH OF BUS AND ELECTRODE ASSEMBLY

of the cascade, discharging into a launder located between the fourth and fifth tank below the floor level. Another portion of cooling water is pumped through the coils of the lower four cells of the cascade and is discharged into the same launder.

The neutral zinc solution from the leaching plant is stored in two 60 ft. x 12 ft. wood-stave tanks from which it flows through a wood-stave pipe into an open launder running the length of the tank room. From this launder the solution runs through iron pipes and is fed to each cell of the cascade, the amount being controlled by a wooden beer-spigot which is attached to the iron supply pipe by a short length of rubber hose. The amount of feed is so controlled that the content of the effluent solution is between 20 and 25 G. P. L. zinc which corresponds to an acid content of about 55 G. P. L. $H_2SO_4$. This flow amounts to about seventy tons of solution per thirty-two cells per twenty-four hours.

There are twelve separate electric circuits for No. 2 tank room, each circuit consisting of two rows of tanks, making thirty-two cells per circuit. The generator room is located in a separate building which parallels both No. 1 and No. 2 tank rooms. In the generator room are located six motor generator sets supplying current for No. 2 tank room and seven supplying No. 1 tank room. Each set consists of one 1,158-kva., 2,200-volt, sixty-cycle, 600-r.p.m. induction motor direct connected to the 500-kw., 50/125-volt, 4,000-amp. direct-current generators, the current from one generator supplying one circuit of thirty-two cells. The current flow is from the anode bus on the inside of an end tank of the cascade to anodes, through solution to cathodes, to a cathode-anode bus supported on the concrete partition between cells to anodes, through solution to cathodes and cathode bus on the outside of the tank; in other words, the current flows across the two cells of a tank in series. The current is in series up one row of eight tanks (sixteen cells) and down the next row of eight tanks (sixteen cells). There is thus an anode bus, an anode-cathode bus and a cathode bus for each

tank; the details are shown in Figs. 3 and 4. Each cell contains seventeen anodes and sixteen cathodes, and with a current of 4,000 amp. the current density is 24.2 amp. per sq.ft. of cathode surface. The anodes are spaced 4 in. centers, making the distance from anode to cathode surface slightly less than 2 in.

### Busbars

One difficulty experienced in the electrolysis of zinc from a sulphate solution with lead anodes is the sulphating at the contact between the anode rod and the

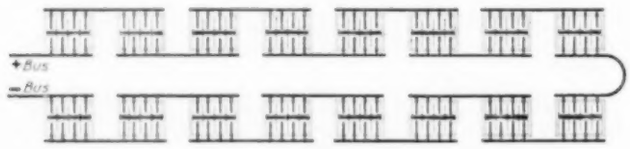



FIG. 4. DIAGRAM OF ELECTRICAL CIRCUIT IN TANK ROOM

lead of the anode. This is due to the acid solution being sprayed on the anode rod by the bubbles of the electrolyte formed by the gas liberated at the anode. The difficulty is entirely overcome by making the anode bus and anode rod of cast lead, and burning the two together. This also reduces the loss due to contacts between an anode rod and a busbar. The anode bus is made of cast lead 5 in. high x 4 in. wide. Four strips of rolled copper ¼ x 4 in. in cross-section, two extending the full length and two one-half the length of the busbar, are cast into the lead. These extend beyond the lead, the free ends being clamped to filler strips of ¼ x 4 in. rolled copper, these in turn being clamped to the cathode bus of the next tank in the series. The anode bus rests on the outer wall of a tank and is insulated therefrom by porcelain blocks.

The anode-cathode bus, which is supported by means of porcelain tiles on the partition which divides the tank into two cells, is also made of cast lead and is U-shaped in cross-section, the horizontal dimension being 4 in. and the vertical 5 in. A longitudinal slightly V-shaped slot 1 in. wide x 2½ in. deep extends the length of the busbar and this slot is faced with rolled copper plates ⅛ x 2 in. The cathode rods are wedged into this

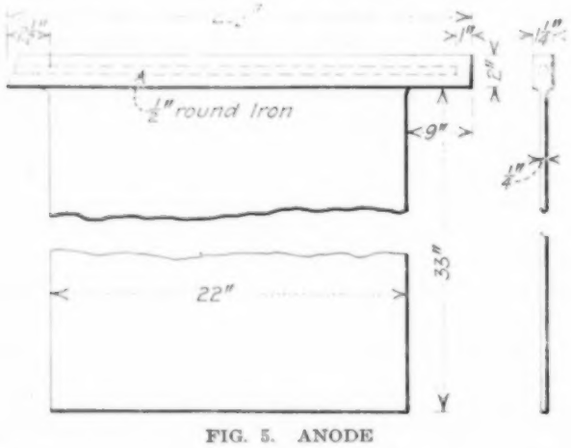



FIG. 5. ANODE

slot when placed in the cell. The rods supporting the anodes in the other cell of the tank are burned to this bus in the same manner as to the anode bus.

The cathode busbar is made of two strips of ¼ x 4-in. rolled copper, extending the length of the tank and spaced 1 in. apart; two additional strips of ¼ x 4-in. rolled copper, one on each side of the center strips, extend one-half the length of the tank. The four strips are clamped to filler strips and make electrical connection to the anode bus of the next tank in series, as previously noted. The cathode rods are wedged into the 1-in. space between the rolled copper strips when placed in the cell. The strips are held in cast iron saddles, as shown in Fig. 3. The cathode bus is insulated by porcelain plates 9½ x 6 x 1¼ in.

The cathode-anode bus rests on special shaped porcelain tiles 6 in. wide. These have a 2-in. x ⅜-in. groove on the upper side in which rests a tongue of the lead of the busbar. The tile has a tongue on the under side which is imbedded in the asphalt on the top of the partition which separates the tank into the two cells. The bus is in this manner held firmly in place and quite perfectly insulated. The cast-iron saddles of the cathode bus rest on flat porcelain insulators and the anode bus is insulated in the same manner.

As the cathode-anode bus is but 4 in. in width, the

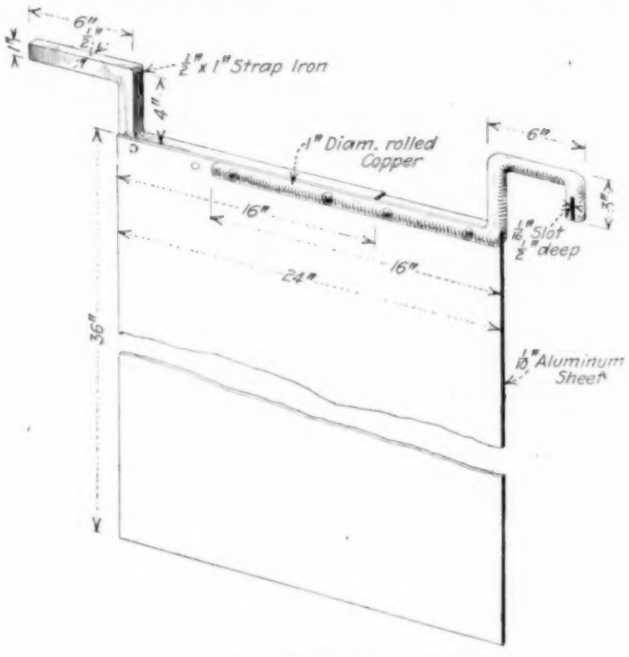



FIG. 6. CATHODE DETAILS

porcelain insulators being 6 in. in width, a free space of 2 in. is left on one side upon which is placed a 2 x ¼-in. wooden strip. This acts as further insulation for the free ends of the anode rods and as a support for them.

### Anodes

The anodes are cast from electrolytic lead and are 22 x 33 in. by ¼ in. in thickness. The anode rod is cast integral and is 2 x 1¼ in. in cross-section, being reinforced by a ½-in. round iron rod. The anode rod is 28½ in. in length extending 2½ in. beyond the edge of the anode on one side and 4 in. on the other. The short end is burned to the busbars, the long end rests on wooden insulator strips which in turn rest on the porcelain tiles. The anodes are immersed in solution to a depth of 31 in. (Fig. 5.)

### Cathodes

Rolled sheet aluminum 1/16 in. thick is used for the cathodes, the dimension being 24 in. wide x 36 in. long (deep). The cathode rod is made of a length of 1-in.

round rolled copper which forms the electrical circuit and a length of 1 x ½ in. strap iron which forms the support at the free end. The details are shown in Fig. 6. It will be noted that the end of the copper rod is split, forming a spring which makes a good contact when the rod is pushed firmly into the slightly wedge shaped slot in the anode-cathode bus or into the space between the two ¼ x 4-in. plates of the cathode bus.

The cathodes are removed one at a time by hand. In order to facilitate the stripping operation wooden strips 25 in. in length and 1 in. square in cross-section having a ½-in. slit in one side are placed on the edges of the cathodes. These are removed during the stripping operation and replaced on the cleaned cathode before it is returned to the cell. Glue is sometimes added to the solutions and produces smooth and coherent deposits.

The cathode sheets are conveyed to the furnace building on narrow-gage trucks. The cathodes are melted in a coal-fired reverberatory furnace having a capacity of about eighty-five tons per day. The slabs are cast in iron molds by means of hand-operated ladles which are supported by a chain from an overhead trolley. Between ½ and 1 per cent of the total production of zinc is made into dust for use in the purification, the dust being atomized by means of compressed air. In order to reduce the amount of dross produced to a minimum, it is treated in a "dross drum" which yields a product comparatively free from metal and the recovered metal is cast into standard slabs.

ACKNOWLEDGMENTS

Thanks are extended to the members of the staff of the Consolidated Mining & Smelting Co. for courtesies extended in visiting the plant at Trail, B. C., and in supplying the information contained in this article.

## Unloading Tank Cars of Flammable Liquids

Colonel Dunn of the Bureau of Explosives has submitted the following draft of instructions for criticism by the petroleum industry. He wishes those having any constructive suggestions to offer them.

1. Raise safety valve to see if there is any interior pressure in tank. Dome cover *must not* be removed while such pressure exists.

Where pressure is found it must be reduced by cooling tank with water or relieved by raising and keeping safety valve open.

2. After pressure is released break seal and remove dome cover as follows:

*Screw Type.*—Unscrew by placing bar between dome cover lug and knob.

*Hinged and Bolted Type.*—Loosen all nuts one complete turn and then sufficiently more to open up cover.

*Interior Manhole Type.*—Carefully remove all dirt and cinders from around cover and then loosen screw in yoke.

3. See that caution signs are placed between switch and first car on siding and left up until after car is unloaded and disconnected. Signs must be at least 12 x 15 in. in size and bear the words "STOP—Tank Car Connected" or "STOP—Men at Work," the word "STOP" being in letters at least 4 in. high and the other words in letters at least 2 in. high. The letters must be white on a blue background. If siding is open at both ends signs must be placed at each end.

4. Move valve rod handle in dome back and forth a few times to see that outlet valve in bottom of tank is properly closed and seated.

5. Remove valve cap with suitable wrench, having a pail in position to catch any liquid that may be in outlet nozzle. If large outlet is to be used remove reducer, first loosening set screws. If valve cap or reducer does not unscrew easily, tap lightly with a hammer in an upward direction.

6. Attach unloading connections securely to nozzle or reducer and raise outlet valve by turning valve rod handle in dome.

7. Replace dome cover but do not entirely close so that air may enter tank for venting as follows:

*Screw Type.*—Engage threads and screw down with wooden block ⅝ in. thick placed against the threads and under outside flange of cover so that when screwed down against this block, the six ½-in. holes bored through the threads will be wholly exposed.

*Ringed and Bolted Type.*—Place wooden block ⅝ in. thick under one edge of cover.

*Interior Manhole Type.*—Tighten up screw in yoke so that cover will be brought up within ½ in. of closed position.

8. When unloading through bottom of outlet of cars equipped with interior manhole type of dome covers and in all cases where unloading is done through the dome opening (unless special dome covers are used, provided with safety vent openings and tight connection for discharge outlet), the dome openings must be protected against entrance of sparks or other sources of ignition of vapor by being covered and surrounded with wet burlap. This must be kept damp by replacements or the application of water as needed.

9. Do not throw seals or other substances into the tank. Also care should be taken to avoid spilling any of the contents over car or tank.

10. After tank is unloaded replace dome cover, valve cap and reducer securely.

11. Flammable placards and railroad defect cards must not be removed.

12. Remove all shipping cards from the car and promptly notify railroad agent when car is empty.

13. Tank cars must not be allowed to stand with unloading connections attached after unloading is completed and employees must be in charge throughout the period of unloading.

14. If necessary to disconnect a tank car during unloading the outlet valve cap must be securely reapplied until unloading is resumed.

Warning: Keep lights and fires away.

## Increasing Demand for High-Grade Asbestos

The demand for asbestos spinning fiber has in late years grown unusually strong, and this demand, coupled with the fact that the United States is largely dependent on Canada for high-grade asbestos, has enabled the asbestos syndicate of Canada, which controls most of the world's supply, to fix prices for the raw material that are so high as to make the manufacture of textile fabrics of asbestos by those outside of the syndicate unprofitable. Thus American manufacturers who do not own Canadian mines are at a great disadvantage. For these reasons much attention has been given to the search for spinning fiber in South Africa and in the United States to meet the increasing demand. The results are encouraging. Three varieties of asbestos are found in the Transvaal, and at some places the mineral occurs in abundance. The imports to the United States from South Africa are increasing.

# Fireclay Mortars for Laying Fireclay Brick*

BY RAYMOND M. HOWE

IN THE making of so-called firebrick mortars it is common practice to add certain materials to the ground fireclay. At times these other materials are added by the manufacturers of the mortar, while at other times they are added by the mason intrusted with the laying of the brick.

Such materials are generally added to make the mortar set firmly without the application of heat, or to offset the natural shrinkage of the clay, or to cause it to burn to a dense structure by reason of decreased refractoriness.

Ground silica and alumina are often added, and since the clay itself is composed almost entirely of these materials, this practice is perfectly legitimate—in fact, the general properties of plastic clay can often be improved by making such additions. On the other hand, it is evident that the addition of certain other materials is not justified, and this paper is designed to show the effect of such additions.

In the experiments here reported, a very plastic fireclay was selected and different amounts of waterglass,

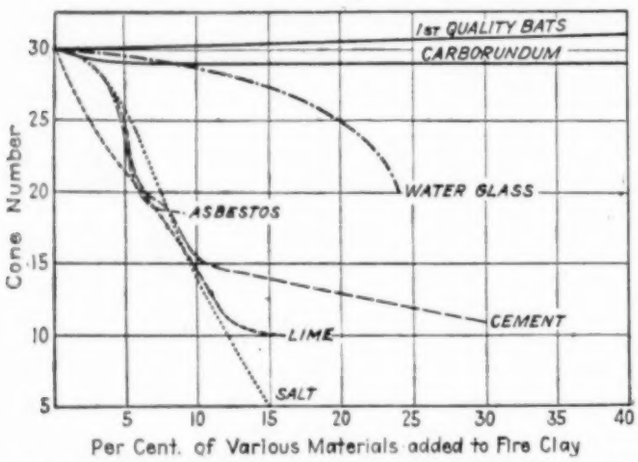



FIG. 1. FUSION POINT OF MIXTURES OF FIRECLAY AND OTHER MATERIALS EXPRESSED IN CONES

salt, portland cement, carborundum, asbestos and lime were added. The analysis of the original fireclay follows:

ANALYSIS OF PLASTIC FIRECLAY USED

| | Per Cent |
|---|---|
| Ignition | 11.12 |
| Silica | 56.42 |
| Alumina | 28.46 |
| Ferric oxide | 3.12 |
| Lime | .52 |
| Magnesia | .44 |
| Alkalis | .24 |
| | 100.32 |

Fusion point, cone 30

After the various mixtures were compounded, small samples of each were fused in the usual type of furnace used in making such determinations. The results of this work are given in Tables I, II, III, IV, V and VI and are shown graphically in Fig. 1.

A careful examination of these data shows very clearly how seriously that addition of lime, portland cement, asbestos and salt affects the quality of fireclay, the addition of only 5 per cent of these materials

*A paper read before a meeting of the Refractories Manufacturers Assn., in Chicago, Ill., Jan. 14, 1920. Published by permission of the Director of the Mellon Institute of Industrial Research.

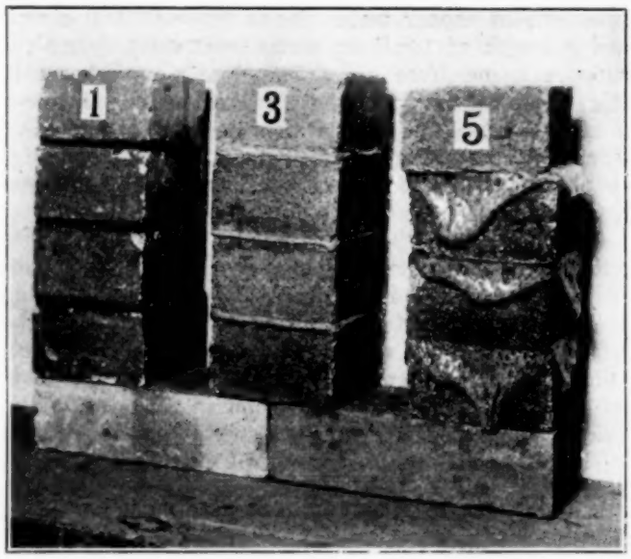



FIG. 2. TEST OF PIERS USING MORTAR NO. 1

lowering the fusion point about 200 deg. F. Waterglass and carborundum did not exert so marked an influence.

The combined effect of the action of asbestos and water glass to fireclay may be appreciated more fully

TABLE I. INFLUENCE OF THE ADDITION OF PORTLAND CEMENT TO FIRECLAY

| Proportion of Clay, per Cent | Proportion of Cement, per Cent | Fusion Point in Cones | Fire Point, Deg. C. |
|---|---|---|---|
| 100 | .. | Cone 30 | 1,730 |
| 96 | 4 | Cone 27 | 1,670 |
| 94 | 6 | Cone 20 | 1,530 |
| 92 | 8 | Cone 19 | 1,510 |
| 90 | 10 | Cone 15 | 1,430 |
| 80 | 20 | Cone 13 | 1,390 |
| 70 | 30 | Cone 11 | 1,350 |
| 60 | 40 | Cone 8 | 1,290 |

TABLE II. INFLUENCE OF THE ADDITION OF LIME TO FIRECLAY

| Proportion of Clay, per Cent | Proportion of Lime, per Cent | Fusion Point, in Cones | Fusion Point Deg. C. |
|---|---|---|---|
| 100 | .. | Cone 30 | 1,730 |
| 96 | 4 | Cone 20-26 | 1,590 |
| 92 | 8 | Cone 17-18 | 1,480 |
| 88 | 12 | Cone 11 | 1,350 |
| 84 | 16 | Cone 10 | 1,330 |

TABLE III. INFLUENCE OF THE ADDITION OF ASBESTOS TO FIRECLAY

| Proportion of Clay, per Cent | Proportion of Asbestos, per Cent | Fusion Point, in Cones | Fusion Point, Deg. C. |
|---|---|---|---|
| 100 | .. | Cone 30 | 1,730 |
| 97 | 3 | Cone 28-29 | 1,700 |
| 94 | 6 | Cone 19-20 | 1,520 |
| 91 | 9 | Cone 18-19 | 1,500 |

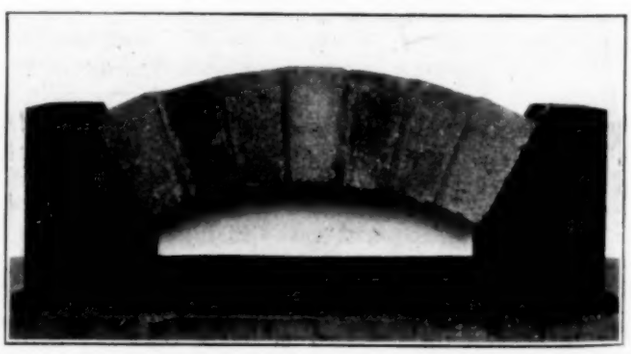


FIG. 3. TEST OF ARCHES USING MORTAR NO. 1 BEFORE BEING HEATED

TABLE IV. INFLUENCE OF THE ADDITION OF WATERGLASS SOLUTION TO FIRECLAY

| Proportion of Clay, per Cent | Proportion of Waterglass, per Cent | Fusion Point, in Cones | Fusion Point, Deg. C. |
|---|---|---|---|
| 100 | .. | Cone 30 | 1,730 |
| 96 | 4 | Cone 29-30 | 1,720 |
| 92 | 8 | Cone 29 | 1,710 |
| 88 | 12 | Cone 28-29 | 1,700 |
| 84 | 16 | Cone 26-27 | 1,660 |
| 80 | 20 | Cone 26 | 1,650 |
| 76 | 24 | Cone 20 | 1,530 |

TABLE V. INFLUENCE OF THE ADDITION OF SALT TO FIRECLAY

| Proportion of Clay, per Cent | Proportion of Salt, per Cent | Fusion Point, in Cones | Fusion Point, Deg. C. |
|---|---|---|---|
| 100 | .. | Cone 30 | 1,730 |
| 95 | 5 | Cone 26 | 1,650 |
| 90 | 10 | Cone 14 | 1,410 |
| 85 | 15 | Cone 5 | 1,230 |

TABLE VI. INFLUENCE OF THE ADDITION OF CARBORUNDUM TO FIRECLAY

| Proportion of Clay, per Cent | Proportion of Carborundum, per Cent | Fusion Point, in Cones | Fusion Point, Deg. C. |
|---|---|---|---|
| 100 | .. | Cone 30 | 1,730 |
| 95 | 5 | Cone 29 | 1,710 |
| 90 | 10 | Cone 29 | 1,710 |
| 85 | 15 | Cone 29 | 1,710 |
| 80 | 20 | Cone 29 | 1,710 |
| 70 | 30 | Cone 29 | 1,710 |
| 60 | 40 | Cone 29 | 1,710 |
| 50 | 50 | Cone 29 | 1,710 |

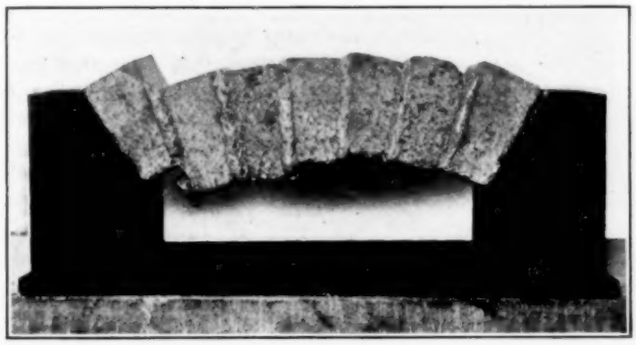


FIG. 4. TEST OF ARCHES USING MORTAR NO. 1, AFTER BEING HEATED TO 1,250 DEG. C. (2,282 DEG. F.)

if a mortar of the following composition (mortar No. 1) be studied. The chemical analysis indicates that about 10 per cent of each of these materials was added to fireclay or silica cement in making the mortar.

ANALYSIS OF MORTAR NO. 1

| | Per Cent |
|---|---|
| Ignition | 8.94 |
| Silica | 72.96 |
| Alumina | 7.64 |
| Ferric oxide | 1.11 |
| Lime | 0.34 |
| Magnesia | 3.01 |
| Alkalis | 6.76 |
| | 100.81 |

Fusion point, below cone 11.

Piers were built in which this mortar was used in making the joints and after being dried they were placed under a pressure of 11 lb. per sq.in. and heated.

Fig. 2 depicts the effect of such treatment, the column marked 1 showing a pier before being heated. The column marked 3 shows the effect of heating to 1,100 deg. C. (2,012 deg. F.) and the column marked 5 the condition of a pier after being heated to 1,250 deg. C. (2,282 deg. F.).

Arches were then constructed, using the same mortar in the joints. Fig. 3 shows a typical arch before being heated, while Fig. 4 shows a similar arch after it had been heated to 1,250 deg. C. (2,282 deg. F.).

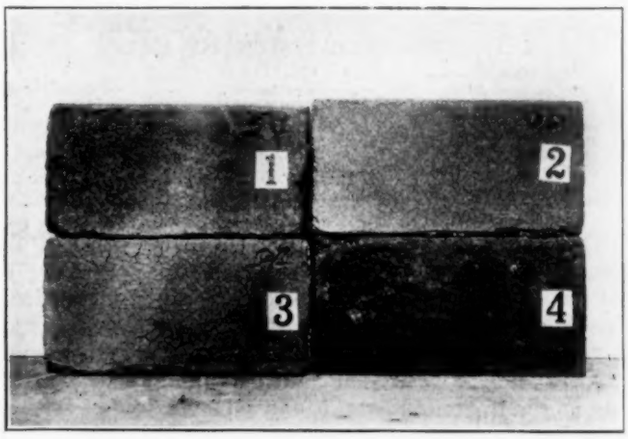



FIG. 5. EFFECT UPON SHRINKAGE OF THE ADDITION OF GROUND FIRST QUALITY BATS TO PLASTIC CLAY

These tests convinced the writer that although the addition of these materials improved the working and setting properties of the mortar, mortars so made should not be used at high temperatures. If they are employed, the foreign ingredients should be used in very small amounts. However, it must be a fact that fireclay, when used alone, does not give a satisfactory joint for some purposes—otherwise no attempt would be made to improve it.

Much of the dissatisfaction which has attended the use of fireclay to which no foreign material had been added can be traced to the shrinkage of the fireclay during the application of heat, for if this tendency to shrink could be overcome, the joints would be firmer, tighter and would not fall out of the arches.

A more logical way to prevent this shrinkage and so establish a firmer joint is not to add foreign materials to the fireclay, but to use the same material, taking the precaution, however, to add a certain amount of clay which had previously been shrunk.

To demonstrate this, some bats of first quality brick were finely ground and mixed with the same fireclay as was used in the other experiments. The effect of this addition upon the fusion point of the clay is shown in Table VII and is decidedly favorable.

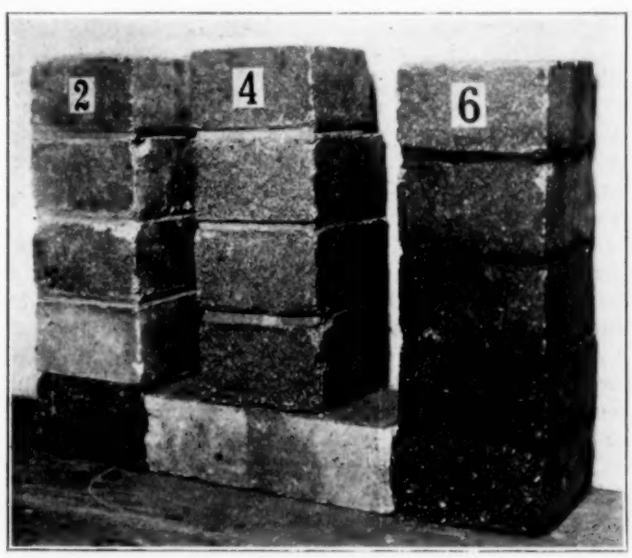



FIG. 6. TEST OF PIERS USING AS MORTAR A MIXTURE OF HALF GROUND FIRST QUALITY BATS AND HALF PLASTIC CLAY

TABLE VII. INFLUENCE OF THE ADDITION OF GROUND FIRST QUALITY BATS TO FIRECLAY

| Proportion of Clay, per Cent | Proportion of Bats, per Cent | Fusion Point, in Cones | Fusion Point, Deg. C. |
|---|---|---|---|
| 100 | .. | Cone 30 | 1,730 |
| 75 | 25 | Cone 30-31 | 1,740 |
| 50 | 50 | Cone 31 | 1,750 |
| 25 | 75 | Cone 31-32 | 1,760 |

The effect upon the shrinkage is shown in Fig. 5, where mixture "1" is 25 per cent plastic clay and 75 per cent ground bats, mixture "2" equal quantities plastic clay and ground bats, "3" 75 per cent plastic clay and 25 per cent ground bats and "4" all plastic clay. It can be seen that "2," containing half plastic clay and half ground bats, is far superior to "4," which is plastic clay alone.

Laboratory tests also showed that the joints made from the mixture of half ground bats and half plastic clay were stronger than those made from plastic clay alone.

Before passing final judgment upon the merits of such a mixture, however, it was decided to subject it to the same tests as were applied to mortar No. 1, and Fig. 6 shows the results of the column tests, "2" not having

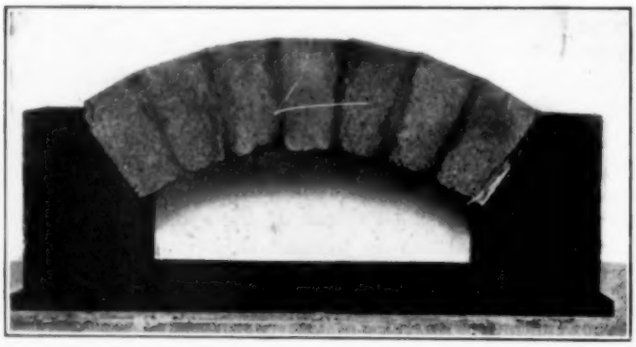


FIG. 7. TEST OF ARCHES USING AS MORTAR A MIXTURE OF HALF GROUND FIRST QUALITY BATS AND HALF PLASTIC CLAY, AFTER BEING HEATED TO 1,350 DEG. C. (2,462 DEG. F.)

been heated, "4" having been heated to 1,250 deg. C. (2,282 deg. F.) and "6" having been heated to 1,350 deg. C. (2,462 deg. F.).

The results of the arch tests are shown in Fig. 7, this arch having been heated to 1,350 deg. C. (2,462 deg. F.). It will be noted that these joints are firm and strong and that they have not begun to soften. As a matter of fact, such joints are stronger when heated to higher temperatures than when heated to the temperature just mentioned.

In conclusion, the writer wishes to emphasize the harmful results which may follow the addition of certain foreign materials to ground fireclay and the good results which may be obtained by the addition of ground bats. In either case, the joints should be made as thin as possible, not only to lessen the chances of harmful results arising from the difference in the structure of the joint as compared with the structure of the brick, but to increase the relative proportion of brick to joint; for at no time can the joint be expected to exert a greater resistance to the action of destroying influences than can the brick itself, particularly if the brick has been selected with a view to resisting conditions such as the finished work will meet.

## Natural Gas Production Figures

The United States Geological Survey has just reported the 1918 production and consumption figures for natural gas. These figures show that a little over 720,000,000,000 cu.ft. was produced and marketed that year. The value of this production at 21¼c. per thousand is a little over $153,000,000. As usual West Virginia, Oklahoma, Pennsylvania and Ohio lead in the production, ranking in the order named. Pennsylvania, Ohio, West Virginia and Oklahoma is the order of consumption, showing as usual the large export of gas from West Virginia to Pennsylvania and Ohio, and the considerable exports from Oklahoma to Kansas and adjacent territory.

There is a very wide range in the average price at which natural gas is sold by the producer in various parts of the country. The figure for Wyoming is 3.59c. per thousand; for New York 67.05c., and for Michigan 89.08c.

There is a decided tendency toward an increase in the percentage of gas sold for domestic uses and a corresponding decrease in the percentage used industrially. This is in line with the recommendations of the Conservation Commission, which has recently been studying the subject, and the natural result of the gradual increase in the price at which gas is sold tended to make its use industrially less advantageous than formerly. This report shows that the 7,100 producers supplied 2,500,000 domestic consumers and 16,500 industrial consumers. The average price paid by the former group is 31.35c. and the latter 15.23c. The total volume of gas used industrially is, however, still considerably greater than that used in domestic equipment, amounting to about 60 per cent of the total. Of this manufacturing takes slightly more than the production of industrial power.

Although about 30 per cent of the wells drilled in 1918 were dry, the total number of wells productive at the end of the year had increased by about 1,000 over the number productive at the beginning of the year. The total number productive Dec. 31, 1918, was 40,369. The land controlled by natural gas producers at the end of the year was nearly one million acres less than at the beginning of the year, indicating a strong tendency toward a smaller acreage of well. This in itself is a decided indication of the decadence of natural gas production. The acreage controlled at the end of the year per productive well was 360 acres.

## Electrolytic Zinc Works in Tasmania

The manufacture of spelter is now being carried on at Hobart in connection with the hydro-electric power scheme installed by the Tasmanian Government. In addition to spelter, zinc sheets are being rolled, and it is proposed to extend the manufacture to the following: Lithopone blocks for marine boilers; zinc shavings for the gold industry; zinc dust for sherardizing metallic aluminum; ferro-alloys; zinc alloys; zinc chloride; zinc sulphate; caustic soda; bleaching powder; other chlorine products; and calcium carbide.

The outlay of these works is estimated at £1,500,000 ($7,299,750), and the plant, which is now producing 70 tons of spelter a week, is being extended to produce 100 tons a day. In 1918 these works produced from New South Wales ore 3,822 tons of spelter, valued at £152,880 ($743,990), and in 1919 3,668 tons, valued at £160,660 ($781,552). In addition 285 tons was produced experimentally from Tasmanian ores.

# The Uses of Talc and Soapstone*

## A Summarized List of the Present and Possible Future Uses of Powdered and Massive Talc and Soapstone, With a Brief Analysis of the Factors Upon Which Their More Extensive Use Depends

BY RAYMOND B. LADOO†

THE uses of talc are many, but are not in general well known or fully developed. Within the last decade several companies have realized the possibilities of greatly increased use and have intelligently proceeded to develop some of the fields which seemed most promising. This has had a tendency to lift talc from the obscurity in which it had existed for years, but the work is only started and much remains to be done. Considerably more attention has been paid to the technology and utilization of talc in Germany and Austria than in this country, despite the fact that the United States produces 65 per cent of the world's talc and Germany and Austria combined but 5.4 per cent. In the *Bericht über die Tätigkeit des Verbands der Talcum-Interessen in Oesterreich-Ungarn* (Proceedings of the Austro-Hungarian Talc Association) for the years 1912 and 1913, many notes upon new uses appeared, together with suggestions as to further development of old uses. Aside from a few notes on the use of talc in paper, little has been published in the English language upon this subject. By recent action of the Talc and Soapstone Producers' Association (U.S.A.) funds for research into the properties and uses of talc have been made available, and it is hoped that markets will be materially broadened as a result of this work.

A summary of uses of talc and soapstone is given herewith:

### USES OF POWDERED TALC AND SOAPSTONE

1. *Paper Manufacture.*
   - *a.* Filling or loading of all grades of paper.
   - *b.* Ingredient of coating mixture on glazed or finished papers.
   - *c.* In tissue paper manufacture from sulphite stock.
   - *d.* In the manufacture of blotting and absorbing papers.
   - *e.* For the bleaching of cellulose.
   - *f.* For removal of resin from cellulose.

   Quality: 200 mesh or finer. Colloidal property demanded. Presence of lime sometimes objectionable.
   Color: Colorless; free from ferric salts, for white paper. Color not important for wrapping paper, etc.
2. *Roofing Paper Manufacture.*
   - *a.* Filling or loading.
   - *b.* Coating (to prevent sticking together).
   - *c.* Surfacing.

   Quality: For filling and coating 200 mesh. For surfacing 40 to 80 mesh.
   Color: Negligible.
3. *Textile Manufacture.*
   - *a.* Dressing cloth.
   - *b.* Coating, sizing and bleaching cotton cloth.
   - *c.* Dyeing.
   - *d.* Dry polishing or sizing of pile fabrics.

   Quality: 200 mesh.
   Color: Dependent upon use.
4. *Rubber Manufacture.*
   - *a.* Filling.
   - *b.* Dusting.
   - *c.* Packing material for rubber.
   - *d.* Protective coating for crude rubber.

   Quality: 200 mesh.
   Color: Negligible.
5. *Paint Manufacture.*
   - *a.* Pigments. Absorption of complex coloring matters.
   - *b.* Filler or extender, particularly in mixed paints.
   - *c.* Cold water paints.
   - *d.* Enamel paints.
   - *e.* Waterproof paints for metal, stone and wood protection.
   - *f.* Flexible roofing paints and cements,
   - *g.* Fireproof or fire-resistant paints.

   Quality: 200 mesh or finer. Colloidal property demanded in most paints.
   Color: Dependent upon use.
6. *Soap Manufacture.*
   - *a.* Filler.
   - *b.* Constituent of soap compound.

   Quality: 200 mesh only, colloidal property demanded in (*b*).
   Color: Dependent upon use.
7. *Foundry-Facing Manufacture.*
   - *a.* Replacing graphite.
   - *b.* Mixed with graphite.

   Quality: 200 mesh.
   Color: Dependent upon use.
8. *Toilet Preparations.*
   - *a.* Face powders.
   - *b.* Toilet powders.
   - *c.* Foot powders.
   - *d.* Creams, pastes and lotions.

   Quality: 200 mesh or finer, freedom from grit, iron and lime, good slip. Colloidal property advantageous when used with liquids.
   Color: White or flesh color.
9. *Wire-Insulating Compounds.*

   Quality: 200 mesh.
   Color: Dependent on use.
10. *Lubricants—Liquid or Grease.*
    - *a.* Talc alone.
    - *b.* Incorporated with heavy oils, 40-60 per cent talc.
    - *c.* With water—talc in colloidal state.

    Quality: 200 mesh.
    Color: Negligible.
11. *Linoleum and Oilcloth Manufacture.*
    - *a.* Filling.
    - *b.* Dusting.

    Quality: 200 mesh.
    Color: Dependent on use.
12. *Pipe-Covering Compounds.*
13. *Pottery and Porcelain.*
    - *a.* Body material for china, porcelain and porcelain crucibles.
    - *b.* Glaze.
14. *Electrical Insulation.*
    - *a.* Artificial or synthetic lava—talc with binder.
    - *b.* Substitute for electrical porcelain—talc with clay with or without liquid binder.

    Quality: 200 mesh.
    Color: Dependent upon use.
15. *Rope and Twine Manufacture.*
    - *a.* Filling.
    - *b* Finishing.

    Quality: 200 mesh.
    Color: Dependent upon use.
16. *Leather Manufacture.*
    - *a.* Dressing skins and leathers.
    - *b.* Drying oily leathers.
    - *c.* Substitute for wheat flour in making glace kid.
17. *Cork Manufacture.*
    - *a.* Dusting molds.

    Quality: 200 mesh.
    Color: Negligible.
18. *Oil Manufacture.*
    - *a.* Filtering medium.

    Quality: 200 mesh.
    Color: Negligible.

*Reports of Investigations, U S. Bureau of Mines.
†Mineral Technologist, Bureau of Mines.

19. *Glass Industry.*
   *a.* Polishing powder for glass, especially plate glass.
   *b.* For dimming and clouding glass.
   *c.* Dusting glass bottle molds.

Quality: 200 mesh.
Color: Negligible.

20. *Portland Cement and Concrete.*
   *a.* Ingredient of special cements.
   *b.* As part of concrete aggregate.
   *c.* As surfacing material.
21. *Wall Plaster.*
   *a.* As ingredient.
   *b.* Finishing.
22. *Asbestos Industry.*
   *a.* Ingredient of asbestos shingles, blocks and slabs.
23. *Manufacture of Crayons, Plaques and Blocks.*
24. *Preservative Coating on Stonework.*
25. *Cleaning and Polishing Rice, Peas, Coffee, Beans, Maize, Barley, Peanuts and Other Similar Foodstuffs.*

Quality: 200 mesh.
Color: Negligible—colored talcs used for colored products.

26. *Bleaching Barley Grain of Inferior Color.* Used with sulphur dioxide gas.

Quality: 200 mesh.
Color: Negligible.

27. *Rubber Stamp Manufacture.*
   *a.* Dusting.

Quality: 200 mesh.
Color: Negligible.

28. *Composition Floor Manufacture.*
29. *Insulating Material for Switchboards, Floors of Generating Stations, etc.*
30. *Imitation Stone.*
   *a.* Marble and jointless flooring.
   *b.* Sanitary appliances.
31. *Boot and Shoe Powder.*

Quality: 200 mesh.

32. *Glove Powder.*

Quality: 200 mesh.
Color: White.

33. *Dermatology.*
   *a.* Absorbing colors, colloidal solutions, fats and oils.
   *b.* Absorbing odors.
34. *Absorbing Colors of Animal, Plant and Artificial Origin.*
35. *Veterinary Surgery.*
   Used for dusting wounds and sores and in treating skin diseases of cattle and other animals.
36. *Purification of Waste Waters.*
   *a.* Purifying, decolorizing and degreasing.

Quality: 200 mesh, colloidal properties demanded.
Color: Negligible.

37. *Manufacture of Water Filters Similar to Berkafeld.*
38. *Conserving Fruits, Vegetables and Eggs.*
39. *Sugar Refining.*
40. *Contact Material for Catalytic Reactions.*
41. *Absorbent for Nitroglycerine.*
42. *Packing Material for Metallic Sodium and Potassium.*
   Used wet with oil.
43. *Fireproofing Wood.*
   Used with sodium silicate (waterglass).
44. *Acid-proof and Fireproof Packing and Cement.*
   For pipe, etc.
45. *Automobile Polish.*
46. *Fertilizer Manufacture.*
   *a.* As filler.
47. *Agriculture.*
   *a.* As filler or extender for insecticides.
   *b.* As ingredient of remedies for plant diseases, e.g., "Foshit" or mixture of copper sulphate with ground talc or soapstone.
48. *Shoe Polish and Cleaner.*
   *a.* As cleaner for white canvas and buckskin shoes.
   *b.* As ingredient of polish for leather shoes.
49. *Yarn and Thread Manufacture.*
   *a.* As dressing.
   *b.* As polish.
50. *Chemical—Pharmaceutical Industry.*
   *a.* As powder.
   *b.* As tablets.
51. *Colored Crayons.*
   *a.* Crayons of chrome colors, pastel colors, etc.
52. *Stove Polishes.*
53. *Imitation Amber.*
   Used for clouding effects.
54. *Cleaning and Glossing of Hair and Bristles.*
55. *Floor Wax.*
56. *Terrazzo or Mosaic Flooring.*
   Used in place of oil in laying terrazzo.
57. *Candy Manufacture.*
   Used with starch, etc., as dusting agent to prevent sticking in molds, on molding boards, etc.

### Uses of Massive Talc and Soapstone

1. *Lava Blanks for Electrical Insulation, Gas Burner Tips, etc.*

Quality: Massive, fine grained talc, free from iron and grit, no cracks of cleavage planes. Must be soft and easily machinable but compact and strong. Must be tested under heat.
Color: Negligible in raw state, but white color preferred when burned.

2. *Crayons and Pencils.*

Quality: Compact, massive talc, medium hard, strong when sawed into thin, narrow strips.
Color: Negligible.

3. *Tailors' Chalk or French Chalk.*

Quality: Compact and strong, fine grained, but medium soft.
Color: White or light color.

4. *Glass Making.*
   *a.* Molds for bottles, watch glasses, etc.
5. *Metallurgical Industries.*
   *a.* Molds for casting of iron, brass, copper, etc.
6. *Refractories.*
   *a.* Firebrick and blocks.
7. *Polishing Agent.*
   *a.* Wooden handles, etc. Small blocks of talc tumbled in cylinder with wooden handles to fill grain of wood and give rough polish.
   *b.* Polishing and lubricating wire nails used in automatic box-nailing machines. Blocks of talc tumbled with nails.
8. *Carvings.*
   Chinese and other Oriental carvings.
9. *Cooking Utensils.*
   Used by uncivilized natives in various parts of the world.
10. *Soapstone Slabs.*
   *a.* Electrical switchboards and base plates.
   *b.* Acid-proof laboratory tables, sinks, hoods, tanks, etc.
   *c* Laundry tubs and sinks.
   *d.* Fireless cooker stoves.
   *e.* Foot warmers.
   *f.* Griddles.

In the investigation of present and possible future uses of talc, it must be remembered that talcs, in common with the other non-metallic minerals, do not have definite and constant physical and chemical properties and that results obtained in the study of one talc will not necessarily hold true for all talcs. Talcs probably do not vary as widely as clays, but, nevertheless, a variety of talcs should be studied for each use. Thus, in testing talc for use in porcelain bodies, one ceramist might find the fusion point of talc low and the range of vitrification very short; another might find a high fusion point, with a long vitrification range and a slow uniform fusing. Both might be right, for the particular material used; but neither result could be said to be true for all talcs. Furthermore some materials sold and used as talcs are not talc at all, strictly speaking, but pyrophyllite, or a hydrous aluminum silicate instead of a hydrous magnesium silicate. It is thus very important that representative samples of a wide variety of talcs be tested uniformly in all research work.

Some of the properties of ground talc which should be determined are:

(1) *Physical Properties.* Grain size, shape of grains, color, impurities, melting point, vitrification range, absorption, bonding strength, "slip," colloidal properties.

(2) *Chemical Properties.* Presence of lime, iron and other impurities, amount of uncombined water.

The reader should not assume that the foregoing list of uses is complete. The Bureau of Mines would be glad to receive suggestions as to further uses.

# Studies In Evaporator Design*—I

## The Effect of Temperature Drop and Temperature Level on Heat Transmission in Vertical Tube Evaporators—Corrections for Hydrostatic Head—Boiling Points, Heat Drops and Steam Temperatures as Factors

By W. L. BADGER and P. W. SHEPARD

THIS paper is the first contribution resulting from the work of the evaporator experiment station at the University of Michigan. It is expected that it will be followed at intervals by a series of similar papers, each one of which will be a contribution in itself, but all of which will ultimately bear on the general question of the transmission of heat from steam to water.

The experiments here reported cover determinations of heat transmission coefficients in a vertical tube evaporator in three series, at boiling points of 60 deg., 75 deg., and 100 deg. respectively. In each series the boiling point was kept constant and by varying steam temperature the mean temperature difference was varied. All known variables, other than temperature drop, were eliminated as far as possible, so that the results are strictly comparable. Also, such conditions were chosen and such records taken that all these runs will be related to other investigations now in progress.

### Prior Literature

A qualitative discussion of the various factors affecting heat transmission from steam to water is given in so many places that it will not be taken up in this paper. The subject is treated by different authorities from different points of view, but the analysis by Claassen [Beet Sugar Manufacture, translated by Hall and Rolfe, 2nd ed. (1910), pp. 133-4] seems to be the simplest and at the same time the most comprehensive. Claassen makes the following statement:

". . . . . the heat transference from steam to the boiling liquid is in proportion to:

"1. The speed of the movement of the liquor over the heating surface.

"2. Inversely as the height of the liquor, or its pressure, on the heating surface.

"3. The speed with which the steam circulates over the heating surface.

"4. The speed and thoroughness with which the condensed water is taken away from the heating surface.

"5. The completeness of the vacuum in the evaporating chamber.

"6. The conductivity of the heating surface—that is, its freedom from scale and foreign substance.

"7. Inversely as the viscosity of the liquor.

"8. The temperature of the liquor, which depends upon the pressure under which it boils.

"9. The magnitude of the temperature drop between the steam and the boiling liquor."

Claassen has investigated the effect of temperature drop and temperature level on the coefficient of heat transmission on a laboratory scale (*Z. Ver. Zukerind.*, vol. 52, p. 373). The work was done in 1895. The experiments were made in a cylindrical vessel 19 in. in diameter and 45 in. high. The heating surface was a copper coil, 45 mm. (1¾ in.) outside diameter with a heating surface of 0.5 sq.m. (5.38 sq.ft.). The whole apparatus stood on a scale. It was filled with water to a definite mark and a definite weight was boiled off. The heat transmission was calculated on the amount of water evaporated and not on the amount of steam condensed. The temperature drop was the difference between the temperatures of steam and of water as determined by mercury thermometers. The data in Claassen's article are too meager to permit recalculation to the true temperature drop (corrected for hydrostatic head). Claassen's results are therefore apparent conductivities.

Claassen's results are given in Table I and plotted in Fig. 1.

Throughout this paper thermal conductivities will be expressed as large calories per sq.m. per deg. C. per hr. and will be designated by $K$. The corresponding figure in English units (B.t.u. per sq.ft. per deg. F. per hr.) is usually designated by $U$. $U = 0.2048K$. Practically all work so far done is of such accuracy that simply dividing $K$ by 5 will give $U$ within the limits of error.

Claassen says: "These experiments show that within the limits of experimental error, the heat transmission coefficient increases with increasing temperature drop. This may be explained by the fact that circulation of the water is favorably affected by the increased number of steam bubbles, due to the higher temperature drop. The summary also shows that with equal temperature drops, the heat transmission coefficient is greater the higher the temperature of the heating steam and the higher the temperature of the vapors or the boiling point of the water. The explanation for this is readily understandable. At a lower boiling point (which may be caused by decreased pressure in the boiling chamber), the vapors evolved occupy a larger volume and consequently continually cover, on the average, a larger part of the heating surface. At higher temperatures of heating steam, the heating steam is denser and can probably give up its heat more rapidly. But principally the increased temperature of the condensed water is of importance here since heat transmission from water to a heating surface proceeds noticeably faster at high temperatures."

Comparatively little attention apparently has been paid to Claassen's experiments and most workers have continued to calculate heat transmissions on the basis of the idea that it was strictly proportional to temperature drop. Hausbrand (Verdampfen, Kondensieren und Kuhlen, 6th edition, 1918, p. 58) says: "The *temperature* of the heating steam must always be a few degrees higher than the boiling point of the liquid evaporated. The greater the temperature difference between heat-

*Read before the American Institute of Chemical Engineers, June 27, 1920

TABLE I.

| Heating Steam, Deg. C. | Boiling Point, Deg. C. | Temp. Drop, Deg. C. | *K* |
|---|---|---|---|
| 110.5 | 100.0 | 10.5 | 1,823 |
| 115.3 | 100.0 | 15.3 | 2,296 |
| 120.2 | 100.0 | 20.2 | 2,611 |
| 124.8 | 100.0 | 24.8 | 2,947 |
| 100.7 | 86.3 | 14.4 | 1,435 |
| 109.9 | 86.1 | 23.8 | 2,527 |
| 115.3 | 86.5 | 28.8 | 2,672 |
| 119.7 | 86.5 | 33.2 | 2,889 |
| 124.0 | 86.2 | 37.8 | 3,185 |
| 100.0 | 71.0 | 29.0 | 2,126 |
| 105.0 | 70.7 | 34.3 | 2,670 |
| 110.2 | 69.4 | 40.8 | 3,007 |
| 114.9 | 72.1 | 42.8 | 3,140 |
| 119.5 | 70.4 | 49.1 | 3,423 |
| 124.7 | 73.0 | 51.7 | 3,619 |
| 98.0 | 60.5 | 37.5 | 2,477 |
| 100.0 | 60.9 | 39.2 | 2,741 |

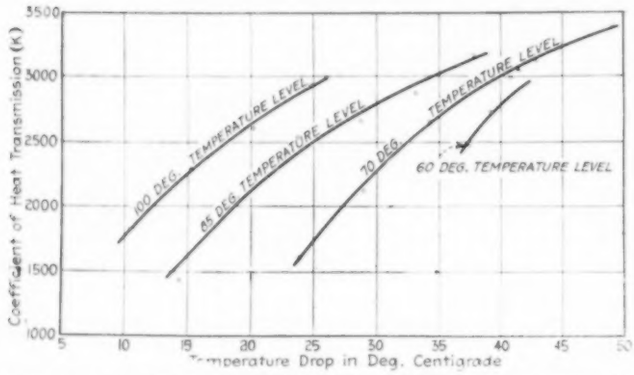



FIG. 1. EFFECT OF TEMPERATURE LEVEL AND DROP ON HEAT TRANSMISSION

ing steam and the liquid the larger the amount of heat transmitted, and it is usually assumed (probably correctly) that the heat passing through unit surface in unit time is directly proportional to the temperature difference."

Hausbrand qualifies this, however, with the following statement: "It seems, however, that we may conclude from many observations that with increasing pressure of heating steam (which of course always brings a higher temperature) a certain increase is found in capacity calculated to 1 deg. difference; this increased activity is not proportional to the temperature rise, but seems to grow slower after passing certain temperatures.

"One reason for this phenomenon is probably to be found in increasingly more rapid movement of the liquid particles over the heating surface at higher temperatures. But this alone does not suffice for the explanation of the observation made so often of a great decrease in heat transmission at low pressures of heating steam (e.g., in multiple effect evaporators) and its increase at elevated pressures."

Nowhere in his actual data or in his formulas does Hausbrand take further cognizance of this effect of varying temperature drop. Orrok (*Trans.*, A.S.M.E., vol. 32, p. 1139) has shown that in surface condensers, heat transmission varies as $\frac{C}{\theta^{\frac{1}{3}}}$. This, however, is of no significance as regards evaporators except by offering an example of heat transmission not directly proportional to temperature drop. Derr states (Hawaiian Sugar Planters Assn., Bull. 42; *Intern. Sugar J.*, vol. 16, p. 471) as the result of large-scale tests the rate of evaporation increases more rapidly than the temperature difference increases.

Kerr (Bull. 149 La. Agr. Exp. Sta.) studied this point to a certain extent. His experimental data, however, are not suitable for interpretation on this point, as his experiments involve too many variables. On page 34 he discusses this matter and cites a number of results from which he concludes that

$$U = 225 + 17500D$$

where $D$ is the density of the heating steam in lb. per cu.ft. Orrok (*Trans.* A.I.M.E., vol. 38, p. 106) has pointed out the great discrepancies in Kerr's work as reported. It will be noted that in Kerr's experiments the effects of temperature difference and temperature level are confused. Kerr ran his experiments by varying the boiling point and varying the steam pressure at the same time but so that, in general, the temperature difference was not constant. When the temperature difference was constant, neither boiling point nor temperature of heating steam was constant. Kerr plots his results in terms of steam temperature without taking cognizance of temperature level or temperature drop. The effect of these two factors is shown in this paper to be very considerable. Consequently no conclusions may be drawn from experiments where they are neglected.

Kerr has also reported (*Trans.*, A.S.M.E., vol. 38, p. 67) heat transmission coefficients from a large number of commercial evaporators operating under plant conditions. Here again, due to failure to compare those results which were obtained with the same temperature drop or with the same temperature level, his results are valueless in this present investigation, except as they show qualitatively an increase in heat transmission with increased temperature drop.

Kerr has endeavored to attack directly the question of relation between temperature drop and heat transmission (Bull. La. Agr. Exp. Sta. 149, p. 41). He quotes six tests in which the temperature drop varied from 5.7 to 18.8 deg. F., plots them, and says that they determine a horizontal line—i.e., that rate of heat transmission is independent of temperature drop. It should be noted first, that the points plotted bear no resemblance to the numerical values in the table from which they are supposed to be taken; second, that the numerical values given in the table, when plotted, do not determine a straight line or any other curve, ranging among themselves by over 100 per cent; and third, so small a range was covered by the experiments that they have no general significance.

It seems probable, in the light of the work reported in this paper, that if Kerr's results, both laboratory and plant tests, had been plotted in such a way as to eliminate variations in either temperature level or temperature drop, they might prove to be much more systematic than is apparent.

## Description of Apparatus

The work reported in this paper was conducted in the vertical tube evaporator described in the previous paper.[1] The arrangement is shown in Fig. 2. The evaporator is 30 in. in diameter and the body measures 12 in. from bottom flange to cover flange. The steam basket is 18 in. outside diameter, 48 in. high and carries twenty-four 2-in. 13-gage charcoal iron tubes, giving a heating surface of 6.315 sq.m., or 67.95 sq.ft. Steam is supplied through a 3-in. steam line and the condensate is removed from the steam basket by a 2-in. pipe. The

[1]See CHEM. & MET. ENG., vol. 23, No. 3, July 28, 1920, p. 1

evaporator was equipped with a round bottom throughout the course of the work. The various auxiliary apparatus is described in the paper previously mentioned, and the methods of measurement are discussed in detail later.

## Test Operation

All experiments here reported were made on distilled water. The evaporator was started boiling and vacuum, steam pressure and feed were adjusted to their proper value. Care was taken to have this preliminary period last long enough so that all conditions became uniform and so that the steam basket and condensate receiver were thoroughly vented of air. As a general thing one person operated the machine, one person recorded and one person attended to feed supply, pumps, etc. When conditions were judged to be uniform, a signal was given, the starting time was recorded and the level of condensate in the receiver was also noted. The desired temperatures and pressure readings were taken every two minutes during a run. Pressures were read to 1 mm. and temperatures were estimated to tenths of a degree. When a sufficient amount of condensed water had been obtained, at a signal from the recorder the time was taken and the valve in the condensed water line closed. The vacuum was immediately broken and the evaporator was shut down. This method was used during the early part of the work and is represented by such experiments as bear either a single number or a number followed by a letter only.

Later in the work a different method was adopted for ending the tests. When sufficient condensed water had collected, at a signal from the recorder the time and the level of the condensate were noted, but operation of the evaporator was not interfered with, the readings of time and condensate level for the end of one run being the readings for the beginning of the next run. Generally, however, the runs produced enough condensate so that at the end of one run it was necessary to cut over into another condensate receiver, in which case a lapse of several minutes was allowed between the end of one run and the beginning of the next. The evaporator, however, was regulated as accurately as possible through this interval just as during the run proper. Where several runs were made in sequence without a shut-down of the evaporator, they are indicated by a number or a number and a letter followed by a dash and a Roman numeral.

## Measurements

*Level.* All these experiments were made with the water level even with the top tube sheet. In a few runs this level was regulated by hand. In such cases the distance of the water level above or below the reference point on the gage glass was read every two minutes. The maximum variation with hand regulation was never more than 3 in. from the desired point, and the average variation for a run was less than $\frac{1}{2}$ in. In most of the runs a Tagliabue liquor level regulator was used. This kept the static level within $\frac{1}{2}$ in. of the desired point at all times. Even when boiling was so violent that the liquid was splashing several feet into the air, sudden shut-down of the machine showed that the static level was still always accurate. In another paper the effect of hydrostatic head is discussed; and it will be evident from the curves there shown that no appreciable error in the value from the heat transmission coefficient could result from such variations in liquor level as occurred.

*Time.* An ordinary watch was used in determining the time of starting and stopping. It is believed that an error of not more than two seconds is the maximum under the conditions of operation. Since the majority of the runs were over twenty minutes long, this means that the error in determining the starting and stopping points of these experiments was of the order of 0.2 per cent and in most cases considerably less than this.

*Boiling Temperature.* The pressure in the vapor space was determined by a mercury manometer and regulated by the vacuum regulator described in the previous paper. The accuracy of regulation was variable, being much greater at the lower pressures. On the

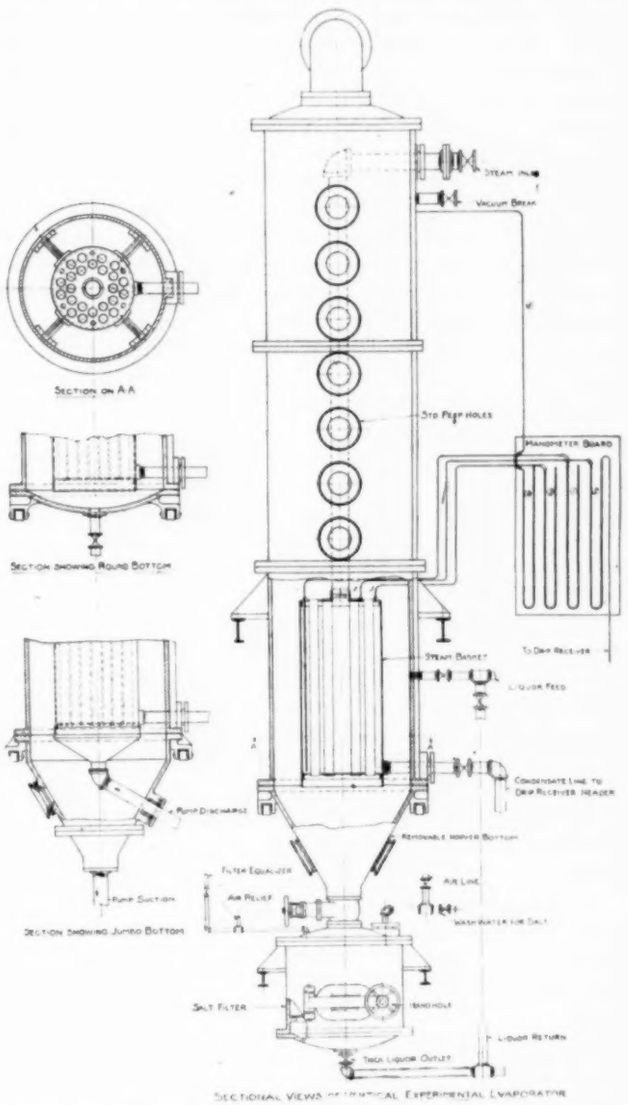



FIG. 2. DIAGRAMMATIC SKETCH OF VERTICAL TUBE EVAPORATOR

average, the variations from maximum to minimum seldom amounted to 10 mm. Since readings were taken every two minutes and since the runs were all over twenty minutes long, it will be seen that the average reading will have a probable error of considerably less than 1 mm. In the few cases where this probable error of the average was actually calculated, it was of the order of 0.01 mm. From tables of the vapor pressure of water, the temperature of the boiling liquid was calculated on the basis of this average pressure. An error of 1 mm. in the average pressure would make a difference of about 0.15 deg. in the 60 deg. series, about

0.08 deg. in the 75 deg. series and 0.02 deg. in the 100 deg. series. It is believed that unknown errors could hardly result in an error of more than 2 mm. in this pressure. This would not amount to over 6 per cent in the extreme case—the runs with 5 deg. temperature drop at the 60 deg. level.

### Steam Temperature

This is the point which caused the greatest difficulty and which is probably the cause for most of the variations noted in these experiments. A reference to Fig. 2 will show that for a number of feet the steam travels through a pipe entirely inside of the machine. Since it is the pressure and temperature of the steam in the steam basket which are of importance, measurements of these quantities outside the evaporator would be of no significance. It is obvious that direct reading thermometers in the steam basket are impossible. At the beginning of this work considerable time was spent in attempts to measure the steam temperature with thermocouples. This was a total failure due to the fact that if the thermocouples were protected, they were not sensitive enough; and if they were bare, their readings were complicated by galvanic emf.'s. Preliminary work showed that they could not be relied on to as close as 1 deg. C. Funds have not been available to provide a precision resistance thermometer, which is probably the one way of measuring the steam temperature with sufficient accuracy.

The only method left was to measure the pressure of the steam and calculate its temperature from the steam tables. Seamless copper tubing was inserted into the steam basket through stuffing boxes through the wall of the evaporator and connected to mercury manometers on the instrument board. One of these connections went just through the top of the steam basket; and one of them was carried to within 2 in. of the bottom of the basket. These two manometers never differed by more than 3 mm. and were usually much closer than that. The average of these manometer readings should be of the same order of accuracy as the average of the vacuum manometer discussed above and would give a correspondingly accurate value for the temperature of the steam, provided the steam contained no air and was not superheated.

At high steam pressures it was not possible to prevent the copper manometer lines filling with steam. The resulting condensation was very troublesome. So far as it resulted in water collecting in the manometers it could be allowed for. But there were always variations in readings in these cases which seemed to be due to water pockets in the tubing. This is the main reason for the small number of determinations at steam temperatures above 115 deg.

A small number of these experiments were made with low pressure from the university's mains, while the larger number were made with high-pressure steam which was throttled down to give the desired pressure in the steam basket. The fact that this high-pressure steam was generated largely from return water from the university's heating system means that it probably contained very little air. The 2-in. line from the steam basket to the condensate receiver was not filled by the amounts of water condensed in even the runs of highest capacity. A ½-in. equalizer line from the drip receiver to the vapor space of the evaporator was always kept partly open. This resulted in a constant flow of steam and non-condensed gases from the basket to the drip receiver, and from the drip receiver to the vapor space of the evaporator. In order to control this venting, another manometer (called the equalizer manometer) was installed. One side of this was connected to seamless copper tubing which ran into the top of the steam basket and down to within 2 in. of the bottom. The other side of the manometer was connected to the vent line a little above the top of the receivers. This manometer then showed the pressure drop between the bottom of the steam basket and the top of the drip receiver. The vent line from the drip receiver to the evaporator was throttled until this pressure drop was about 10 mm. of mercury. Comparative experiments showed that this was a much greater drop than necessary, but this figure was used to be on the safe side. Since the steam basket used is comparatively long for its diameter, the non-condensed gases will be swept to the bottom and out through the condensate line. Therefore it is believed that the steam in the steam basket contained very little air. If we accept Orrok's conclusion for surface condensers—that the heat transmission coefficient decreases as the third power of the steam richness—1 per cent of air in the steam would cause a decrease in heat transmission of about 3 per cent. In the case of those runs where the pressure in the basket was much below atmospheric pressure, there may have been this much air or more in the steam basket. The connections to the drip receivers are so complicated that there is a correspondingly large number of chances for air leaks; and the greatest difficulty was experienced in getting checks in the runs at highest vacua. Through most of the work, however, it is believed that less than 1 per cent of air was present.

It is, however, quite certain that there was some superheat in the steam in a great many cases. The steam as it comes to the evaporator is wet, but since throttling at the regulating valve results in superheat, it has not been thought worth while to make moisture determinations on the part of the steam line which is available. To what extent moisture and superheat offset each other by the time the steam reaches the steam basket it is very difficult to say. Runs with the steam at about atmospheric pressure have shown no difference between the use of high-pressure steam throttled from 100 lb. down to atmospheric pressure on the one hand, and low-pressure steam with practically no throttling on the other hand.

Work on the horizontal tube evaporator, in cases where similar conditions of throttling existed but where direct measurements of steam temperatures were possible, has shown about 10 to 15 deg. of superheat when throttling to atmospheric pressure. This was in cases were steam flow was at about the same rate as the average rate in these tests. But in the horizontal evaporator the length of steam travel from the throttling valve to the heating surface is much shorter than in the vertical evaporator. Since the reaction between superheat and entrained water takes a measurable time, there is more chance of this equilibrium being reached in the vertical evaporator than in the horizontal. In order to determine the magnitude of the effect of superheat, let us assume a limiting case.

Let $t_1 = 150$ deg = temperature of superheated steam at entrance of steam basket.

$t_s = 100$ deg. = temperature corresponding to pressure in steam basket.

$t_w$ = 75 deg. = temperature of boiling water.

Then $\theta_a = t_1 - t_w = 75$ deg.

$\theta_e = t_s - t_w = 25$ deg.

$\theta_s = \dfrac{\theta_a - \theta_e}{\log_e \dfrac{\theta_a}{\theta_e}}$ = mean temperature difference during transfer of superheat.

$\theta_l$ = mean temperature difference during transfer of latent heat.

$$\theta_s = \frac{75 - 25}{\log_e 75 \div 25} = 43.70 \text{ deg.}$$

$\theta_l = t_s - t_w = 25.0$ deg.

Now if we weight these temperature drops in proportion to the amount of heat transmitted by each, we find that the general mean, $\theta_m$, is

$$\frac{(43.7 \times 24.2) + (25.0 \times 538.7)}{24.2 + 538.7} = \frac{1058 + 13468}{562.9} = 25.8 \text{ deg.}$$

The total heat transmitted is 4.5 per cent too low if the superheat is neglected, and the temperature difference is 3 per cent too low. These errors affect the result in opposite directions, so that the error in this case due to neglect of superheat would be negligible.

This does not take into consideration any difference between heat transmission from saturated and from superheated steam. It does not seem possible that as much as 50 deg. superheat could exist; and unless, due to the presence of superheat, there is a very great difference in the essential phenomena, it would seem that this error is not enough to affect the results materially. Due to the pressure of other work, it has not been feasible to spend either the money or the time necessary to investigate this point further.

### Weight and Temperature of Condensate

In the condensate line immediately outside the evaporator a cross was placed. In the top opening of this cross was inserted a calibrated thermometer with its bulb dipping into a pocket formed by the plugged bottom outlet of the cross. The average of the readings of this thermometer is correct to less than one-tenth of a degree.

Two different procedures were followed in determining the amount of steam condensed. In the case of experiments where the condensed water was cooler than 100 deg., compressed air was turned into the drip receiver at the end of the test and the condensate was blown out through a goose-neck into a weigh tank. Repeated trials of this method showed an accuracy always greater than 5 lb. When the water was above 100 deg. this method could not be used. In such cases the gage glasses were read in mm. at the beginning and end of the test and the weight of water was calculated from calibrations of the receivers. The temperature of the condensate was taken into consideration in making these calculations.

### Temperature Difference

The relation of the determination of steam temperature to temperature difference has been discussed above. Much thought was also given to the figure to be used for the temperature of the boiling water. Calibrated thermometers were inserted into the body at different points and their readings were compared with those calculated from the vacuum as previously described. They differed between themselves by several tenths of a degree, and also from the temperature calculated from the vacuum. Because they were located in the descending current in the downtake and subject to radiation losses, it was felt that the temperature calculated from the vacuum was more reliable than any of them or than their average.

The effect of hydrostatic head is to increase the boiling point in the lower layers of the liquid. The question also arose of correcting the boiling temperature for this. It was finally decided that the results would be most generally useful if calculated on the *apparent* temperature drop (temperature calculated from steam pressure less temperature calculated from vacuum). These are later corrected for hydrostatic head in a separate part of this paper. Where specific mention is not made to the contrary, *apparent* heat transmission coefficients (i. e., calculated on the apparent temperature drop) are to be understood.

The effect of feed temperature is also to be considered. By reasoning similar to that employed in the case of the effect of superheat, it can be shown that the heat transmitted during heating is so small a part of the total heat transmitted that it would not affect the results if this heat were transmitted by a different temperature drop from that employed in the calculations. Further, it is questionable if cold feed ever gets to the layer next the heating surface where the heating is really done. Cold feed is probably heated by mixing with superheated lower layers and from steam bubbles stirred in by the circulation.

### Final Accuracy of Results

When all the above measurements were considered, it is seen that no one of them except the steam temperature and the boiling temperature will affect the temperature drop by more than 1 per cent. There are, of course, factors such as scale or rust on the heating surfaces, variations in circulation and possibly others. It was found possible to obtain agreement between duplicates usually better than 5 per cent, but not always. What the absolute precision of the final results is would be very difficult to say, but the relative accuracy of the work may be judged better by the points on the curves than by numerical statements.

(*Part II will be published in a subsequent issue.*)

## Briquets From Coal in Winnipeg

Published reports say that the Lignite Utilization Board, which has been experimenting for months with the problem of cheaper fuel for domestic use from the low-grade coal found in southeastern Manitoba and Saskatchewan, has arrived at a satisfactory manufacture of briquets.

The chairman of the board has expressed the opinion that the engineers have succeeded in finding a system for the manufacture of briquets that will probably produce fuel equal to the best grade of the United States anthracite coal, and which will be even more satisfactory for domestic use.

The board has decided to erect an experimental plant with a capacity of 30,000 tons a year. The plant will doubtless be located near the mines operating in Saskatchewan, close to the Manitoba boundary.

The chairman of the board further says that a careful analysis of the costs leads to the belief that briquets can be manufactured and loaded on cars at the plant at about $7.50 a ton.

# Legal Notes

By Wellington Gustin

## When a Suit to Which an Alien Is Party Cannot Be Removed From State to Federal Court

United States District Judge Smith at El Paso, Tex., has remanded the case of the Compania Minera y Compradora de Metales, Mexicano, S. A., against the American Metal Co. and the Compania de Minerales y Metales, S. A., from the Federal District Court to the state court.

The plaintiff company is a corporation organized under the laws of the Republic of Mexico. It brought this suit in the Texas state court at El Paso, seeking to recover, from the defendants, damages for the alleged breach of a contract between them. Plaintiff alleges, in its petition, that the Compania de Minerales y Metales, S. A., in making the contract with it and breaching same, was acting as the authorized agent of the American Metal Co., a New York corporation. The American Metal Co. sought the removal of the case to the Federal court on the grounds: (1) Diverse citizenship of the parties and both defendants being non-residents of Texas; (2) that there is a separable controversy between plaintiff and itself; and (3) that the matter in controversy was between citizens of a state and foreign states, citizens or subjects.

The court said a separable controversy to which an alien is a party cannot be removed from a state to a Federal court irrespective of whether the alien is a plaintiff or a defendant. Neither does a Federal District Court have original jurisdiction over a suit brought by an alien plaintiff against an alien defendant and a citizen defendant, and such a suit, therefore, cannot be removed from a state court to a Federal court. Also, where an alien plaintiff sued an alien defendant and a citizen defendant, the suit is not one between citizens of different states within the Federal statute.

## Recovery of Salary and Expenses Not Bar to Action for Damages

The Supreme Judicial Court of Massachusetts of Suffolk has overruled the exceptions of defendant, thus affirming the verdict rendered in the lower court in favor of John J. Dalton in his action against the American Ammonia Co. The action was for damages for breach of a written agreement to employ Dalton for a period of one year at a weekly salary and further compensation payable at the end of the term of 250 shares of stock.

Dalton was discharged by the company some months before the end of the contract period. Dalton sued and recovered back salary and expenses in a former proceeding, and to the present action the ammonia company filed a plea to dismiss because of the former action. It contended that in the former action Dalton elected to treat the contract as rescinded and recovered the value of the service actually performed, and therefore could not pursue an inconsistent remedy and recover damages for the breach, based upon affirming the contract.

In its opinion the court has said that when a special contract of employment is broken by the employer without the employee's fault, and the latter, disaffirming and considering the contract at an end, sues for value of services rendered, he may recover the full value of services independent of the contract price, as if the special agreement did not exist.

Again, where an employee, wrongfully discharged, recovered on an account annexed for expenses and installments of salary due under the contract, he did not elect by such action to consider the contract as terminated, and his second action for damages for breach of contract is not barred by any election of remedies given him under the laws. And by merely suing for the salary accruing for the two weeks following discharge, and subsequent to the bringing of the action, he did not make a decisive election, inconsistent with his subsequent action for damages for breach of the contract.

## Corporation May Not Replevin Formulas and Stock

In a decision by the Appellate Term of the Supreme Court of New York, it appears that two of the incorporators of the plaintiff corporation, Loebmann & Sullivan, agreed by written contract to purchase the formulas, trade-name and all rights of every kind relating to a certain "one-cote paint," together with defendant's stock on hand, in consideration of the payment of $150 at time of agreement and $150 when a corporation was organized, and 150 shares of stock of the company, when organized for the purpose of taking over all of the property. These shares were to be one-half of the number of shares issued at the time of organization, "which half will be specified in the certificate of incorporation to be half of the stock with which the company will begin business, the balance to remain as treasury stock."

Loebmann & Sullivan, on or about the date of the incorporation of the One-Cote Products Co., assigned to it their rights in the agreement and tendered to defendant a certificate for 150 shares of the company's stock and a check for the balance of the cash due under the contract; but defendant refused to deliver the merchandise or to accept the check or the stock, saying he did not want to go through with the transaction. The court held these facts did not give the company the right to replevin the formulas and other property in defendant's possession. And if there is a cause of action it would be for damages for failure to deliver them.

## Novel Method for Calculating Damages by Jury—Prior Agreement Vitiates Such Verdict

In the case of Will Owen against the Buckeye Cotton Oil Co., of Greenwood, Miss., the jury adopted a novel method of determining the damages due to Owen. The amount was arrived at by adding together the amounts the several jurors thought should be awarded Owen and divided the sums thus obtained by 12, the quotient being the amount agreed on as the jury's verdict.

On appeal from the judgment by the Buckeye Cotton Oil Co. the Supreme Court of Mississippi affirmed the judgment, on the ground that it found no previous agreement among the jurors to so calculate the amount of damages. The court said the quotient method may have been adopted by the jury as an experiment, resulting in each juror afterward becoming convinced that the amount thereby arrived at was equitable.

The objection to such a prior agreement on the jurors' part is that such would cut off all deliberation on the part of the jurors, and place it in the power of a single juror to make the quotient unreasonably large or small by naming a sum extravagantly large or ridiculously low. The agreement in advance to abide by the result alone makes it illegal.

# Experiments on the Corrosion of Iron and Steel*

**Corrosion Losses on Twenty-four Different Kinds of Iron and Steel Were Recorded for a Test Period of 1,000 Days' Immersion in Air and Brine, Quiet and Air Agitated, With or Without Periodical Drying**

By WILLIAM D. RICHARDSON

## Series 1 Experiments

If A piece of piano wire (99.85 per cent iron) or pure open-hearth iron (99.95 per cent iron) be carefully cleaned and rubbed with fine emery, bent U shape and one arm burned in a flame to coat this arm with magnetic oxide (the other arm remaining bright) and if the whole be submerged in ferroxyl jelly, the bright arm becomes quickly surrounded by a blue zone, showing an anodic region, and the oxidized arm by a red zone, showing a cathodic region. The cathodic character of mill scale can be shown also by its behavior toward diluted copper sulphate solution. After coating a piano wire with mill scale (in the flame) cross scratches are made, say $\frac{1}{16}$ to $\frac{1}{32}$ in. apart, exposing the bright iron beneath. When such a wire is inserted in dilute copper sulphate solution, the copper begins to deposit on the magnetic oxide instead of on the exposed iron.

If a sheet of iron be allowed to corrode so that part of the mill scale is removed, or if acid be applied in such a way as to uncover bright iron in spots and leave the scale intact in other places (producing a mottled effect) and if the sheet be then washed and dried, when the ferroxyl indicator is applied the blue and red regions correspond most precisely to the bright iron and mill scale areas respectively. A few exceptions to this general rule may occur owing to the mill scale covering being not quite perfect on the one hand and to the presence of invisible oxidized areas which have formed on the bright iron, during washing. Further, the red phenolphthalein pigment sometimes diffuses over the bright iron and the Turnbull's blue, not being diffusible, does not cover the bright iron until later.

Likewise, if a clean piece of pure iron, mild steel or ordinary sheet iron is rusted in a moist chamber, and half its surface cleaned, the clean part is anodic. Another way of showing the same effect is in covering with ferroxyl a bright piece of pure iron upon which have dried a few separated droplets of water. The rust spot areas always become cathodes, usually entirely, always in part. The bright spots become anodes for the greater part, although it is true that occasionally a red area develops over apparently bright iron. But it is possible that in these exceptional cases the apparently bright iron is covered by a thin invisible oxidized layer. In experiments of this sort the outer edge of the jelly where it is in contact with the metal always turns bright red. This point will be briefly discussed.

It is interesting to note the effect of pouring the ferroxyl jelly on cleaned bright "pure" open-hearth iron. A red border forms at the outer edge of the jelly almost immediately, showing that the metal here is cathodic. Next to this a blue band develops and the interior is at first faint pink, but in the end the interior usually becomes blue provided the ferroxyl jelly covers only a moderate area. The red border, which is always intense, begins to form at the extreme outer edge of the jelly where it is in contact with the metal. Here the oxygen of the air would have the greatest depolarizing action and it is reasonable to suppose that we have here in effect the action of an oxygen cathode. In connection with the rust and mill scale experiments, this one is interesting in showing how surface conditions may easily outweigh in electrolytic effect the varying compositions of iron and steel.

## Earlier Tests—Series 2 Experiments

Open-hearth ingot iron was welcomed on its advent by all the investigators who adhered to the electrolytic theory of corrosion. In laboratory tests, the pure metal resisted 5 per cent $H_2SO_4$ much better than any other type of commercial rolled sheet. Practical tests, under identical circumstances, of the new iron in comparison with common open-hearth sheets were not proving the new metal to have better corrosion-resisting qualities than the old. Consequently other tests were demanded. A series of tests known as Series 2 experiments was begun as follows:

Twelve pieces of common sheet iron or mild steel and twelve pieces of the pure open-hearth iron were suspended alongside each other in distilled water and in 10 per cent sodium chloride brine at rest, in distilled water and in 10 per cent sodium chloride brine with air agitation. The pieces were of definite area and were all weighed when put into the various liquids. They were taken out at intervals, the adhering rust was removed by suitable means, weighed and the loss in weight calculated to grams per sq.cm. It was thought that conditions represented several service conditions as well as could be expected; for practical reasons the surface of the pieces was not changed by the removal of mill scale before immersion, inasmuch as it was thought best to test the iron as received from the mill. The layer of mill scale on the surface of the metal afforded some protection for a time, but the corrosion gradually removed it, so that ultimately all the pieces were bright under the rust. This removal of the magnetic oxide layer occurred sooner in some pieces than in others, but working on averages there was no essential difference, at various stages, in the pieces of new iron as contrasted with the common iron.

*Extracts from a paper read before the June, 1920, meeting of the Institute of Chemical Engineers. The views on rust set forth in this paper were first publicly expressed in an address before the Chicago Section, American Chemical Society, Jan. 18, 1910, and subsequently before various societies. The experiments described cover the period from 1908 to 1919, inclusive.

Analyses of the two kinds of iron (or mild open-hearth steel) used are as follows:

| | Open-hearth Pure Iron. | Common Iron. |
|---|---|---|
| Silicon | 0.004 | 0.C28 |
| Phosphorus | 0.002 | 0.021 |
| Sulphur | 0.014 | 0.063 |
| Manganese | 0.021 | 0.457 |
| Total carbon | 0.025 | 0.253 |
| Copper | 0.020 | 0.025 |

The loss in grams per sq.cm. was practically identical, on the average, in each case. After eighty-four days' immersion the results (average of six samples in all cases) were as given in Table I:

TABLE I. SERIES 2 EXPERIMENTS

| | Water at Rest. Loss per sq.cm. in Grams. | 10% Brine at Rest. Loss per sq.cm. in Grams. | Water with Air Agitation. Loss per sq.cm. in Grams. | 10% Brine with Air Agitation. Loss per sq.cm. in Grams. |
|---|---|---|---|---|
| Pure open-hearth iron .... | 0.0137 | 0.0080 | 0.0411 | 0.0399 |
| Common open-hearth iron | 0.0121 | 0.0070 | 0.0403 | 0.0402 |

The conclusion drawn from these experiments and from other practical tests was that iron of the purity attained—i.e., 99.95 per cent—had no advantage in rust-resisting qualities over ordinary iron or mild steel, whatever gain there might be in physical qualities.

## Series 3 Experiments

This series of experiments was started in order to ascertain how much acceleration of corrosion could be brought about by pure oxygen over that induced by air alone. The plates used in the experiments were ordinary open-hearth black iron (mild steel) No. 16, 6 x 6 in. square. The conditions to which the plates were subjected were as follows:

1. Water with air agitation, two hours each day.
2. Water with air agitation for two hours each day, plates dried in the air on alternate days, thrice weekly.
3. Water with oxygen agitation, two hours each day.
4. Water with oxygen agitation, two hours each day, dried in the air on alternate days, three days per week.

The reason for limiting the agitation to two hours per day was the large amount of oxygen required if oxygen was used continuously. In conditions 3 and 4 an oxygen atmosphere was maintained (except when the plates were being dried) by confining the entire apparatus under a large bell jar. The results are shown in Table II, and are interesting as indicating the importance of oxygen as an accelerator of corrosion. The plates which were hung submerged in water throughout the experiments, the water being kept saturated or nearly saturated with oxygen, lost 118 g. on the average in 1,000 days, whereas the comparative experiment in which air was used produced a loss of 85 g. The submerged plates remained clean throughout the experiment after the mill scale dropped away, and exhibited to the last a fairly smooth, finely crystalline surface which was covered during the progress of the experiment more or less with soft and flocculent ferric hydroxide. The results indicate clearly that pure oxygen is a more powerful corroding agent than atmospheric air, although corrosion in the presence of air is assisted by a small quantity of $CO_2$, which has been shown to work in a cyclic manner.[1]

The plates which were dried in the air and hence subjected to the enormously accelerating effect of adherent rust were badly corroded and pitted. The oxygen plates were more severely pitted than the air plates. Nevertheless, the loss from the plates exposed to oxygen was less than from those exposed to air. This can be accounted for by the fact that the rust adhered more closely to the oxygen plates than to the air plates and while the deposit was not sufficiently uniform or extensive to protect the plates completely, nevertheless it served to reduce the loss even in the presence of oxygen, which ordinarily, and without the protective action of the adherent rust, would have acted as a stronger corroding agent than the air. In this case the corroding agent and not the composition of the metal modified the behavior of the products of corrosion.

TABLE II. SERIES 3 EXPERIMENTS, WATER IMMERSION

Comparison of Air and Oxygen as Agents of Corrosion

| | Loss in Grams. | | | |
|---|---|---|---|---|
| Age in Days | Air Agitation | Air Agitation, Dried | Oxygen Agitation | Oxygen Agitation, Dried |
| 100 | 8.2 | 5.3 | 12.4 | 6.8 |
| 200 | 15.6 | 10.1 | 24.4 | 15.7 |
| 300 | 22.3 | 17.0 | 35.2 | 24.7 |
| 400 | 32.2 | 30.4 | 43.4 | 33.5 |
| 500 | 40.3 | 45.0 | 66.9 | 48.9 |
| 600 | 50.2 | 56.8 | 74.8 | 57.9 |
| 800 | 68.8 | 76.7 | 107.2 | 70.6 |
| 1000A | 85.0 | 93.7 | 118.0 | 84.9 |
| 1000B | .... | 167.0 | .... | 139.0 |

1000A represents loss before plates were cleaned.
1000B after removal of rust by the sand blast.

## Series 4 Experiments

After the preliminary experiments of Series 1, Series 2 and Series 3 had been concluded it was thought that in view of the partial or the inconclusive nature of the evidence which they afforded, it would be best to start another series of experiments on a number of different varieties of iron which could be allowed to continue under the different conditions for a long period of time. It was hoped from the evidence which such a series would produce that some explanation might be forthcoming as to the reason for the difference between corrosion in acids, in water and under various conditions of service. Series 4 Experiments were the result.[2]

## Kinds of Iron Used in Series 4 Experiments

The varieties of iron and steel made use of in these experiments and their analyses are given in Table III. All the samples measured 6 in. square, practically equivalent to 15 cm. square. The rolled sheets were No. 16, the cast pieces were $\frac{1}{8}$ in. thick. Samples of iron of the same kind from two different manufacturers were used in nearly every case. Twenty-four plates, 6 x 6 in., of each kind were used.

All of the plates experimented on were used in their original condition with their surfaces untreated. Naturally they were all covered with mill or foundry scale except the cold-rolled sheets of pure open-hearth iron. The cast metals presumably had the usual cast metal surface which, as has been pointed out by others, may possibly contain a comparatively high proportion of silicon and thus be more resistant to corrosion than similar metals which have been machined to remove the outer surface. The influence of surface, however, should be taken into account in all cases, although it will be seen from an inspection of the results obtained with cold-rolled pure open-

[1] J. Newton Friend, The Corrosion of Iron and Steel, London, 1911, pp. 35 and 36. Whitney, *J. Am. Chem. Soc.*, vol. 25, p. 394 (1903).

[2] I wish to acknowledge especially the assistance of J. DeRose, O. T. Bloom and L. S. Paddock in carrying out the experiments.

TABLE III. COMPOSITION OF IRONS USED IN SERIES 4 EXPERIMENTS

| | | Per Cent Si | Per Cent P | Per Cent S | Per Cent Mn | Per Cent Carbon—Total | Per Cent Carbon—Graphitic | Per Cent Carbon—Combined | Per Cent Cu |
|---|---|---|---|---|---|---|---|---|---|
| AA | Copper bearing | 0.04 | 0.007 | 0.015 | 0.063 | 0.059 | ..... | 0.059 | 0.12 |
| CC | Copper bearing | 0.03 | 0.C05 | 0.016 | 0.16 | 0.056 | ..... | 0.056 | 0.10 |
| BB | Open-hearth pure iron | 0.04 | 0.008 | 0.015 | 0.024 | 0.030 | ..... | 0.030 | 0.015 |
| II | Open-hearth pure iron | 0.002 | Trace | 0.019 | 0.002 | 0.020 | ..... | 0.020 | 0.023 |
| JJ | Open-hearth cold rolled | 0.007 | 0.002 | 0.016 | 0.023 | 0.020 | ..... | 0.020 | 0.025 |
| KK | Open-hearth cold rolled | 0.008 | 0.002 | 0.013 | 0.020 | 0.030 | ..... | 0.030 | absent |
| UU | Open-hearth iron | 0.008 | 0.015 | 0.043 | 0.433 | 0.164 | ..... | 0.164 | 0.021 |
| WW | Open-hearth iron | 0.004 | 0.020 | 0.041 | 0.282 | 0.097 | ..... | 0.097 | 0.030 |
| TT | Bessemer iron | 0.C05 | 0.075 | 0.290 | 0.450 | 0.119 | ..... | 0.119 | 0.030 |
| VV | Bessemer iron | 0.008 | 0.025 | 0.033 | 0.407 | 0.132 | ..... | 0.132 | 0.020 |
| DD | Genuine puddled iron | 0.14 | 0.12 | 0.014 | 0.31 | 0.023 | ..... | 0.023 | absent |
| EE | Genuine puddled iron | 0.15 | 0.17 | 0.019 | 0.030 | 0.030 | ..... | 0.030 | Trace |
| XX | Charcoal iron | 0.003 | 0.052 | 0.013 | 0.029 | 0.060 | ..... | 0.060 | 0.047 |
| FF | Gray cast iron | 2.71 | 0.82 | 0.120 | 0.32 | 3.21 | 2.62 | 0.59 | absent |
| SS | Gray cast iron | 2.24 | 0.40 | 0.122 | 0.44 | 3.08 | 2.67 | 0.41 | absent |
| LL | White cast iron | 0.81 | 0.137 | 0.054 | 0.251 | 1.35 | 0.05 | 1.30 | absent |
| OO | White cast iron | 0.48 | 0.143 | 0.044 | 0.216 | 1.55 | 0.05 | 1.50 | absent |
| MM | Malleable iron | 0.90 | 0.134 | 0.09 | 0.25 | 0.57 | 0.50 | 0.07 | absent |
| NN | Malleable iron | 0.77 | 0.164 | 0.067 | 0.26 | 2.44 | 1.44 | 1.00 | absent |
| GG | Semi-steel | 2.95 | 0.92 | 0.110 | 0.33 | 3.06 | 2.72 | 0.34 | absent |
| RR | Semi-steel | 2.15 | 0.327 | 0.121 | 0.46 | 3.15 | 2.35 | 0.80 | absent |
| PP | Cast-steel | 0.26 | 0.011 | 0.024 | 0.58 | 0.20 | ..... | 0.20 | absent |
| QQ | Cast steel | 0.23 | 0.036 | 0.041 | 0.58 | 0.21 | ..... | 0.21 | absent |
| YY | Duriron | 15.00 (approximately) | | | | | | | |

hearth iron as against the results obtained with similar metal rolled hot and covered with mill scale that the course of corrosion may be much alike under like conditions even when different surfaces are involved. The most noteworthy difference in the two cases is that the cold-rolled metals subjected to the action of water agitated with air and dried semi-weekly showed a tendency for the rust to adhere more strongly than did the black iron.

The reason for not surfacing the plates was to ascertain the course of corrosion in the case of commercial metals with their ordinary finishes, unmachined and also unprotected by paint or other coating.

### Conduct of Series 4 Experiments

All of the plates were subjected to eight different conditions:

1. Distilled water at rest.
2. Distilled water at rest, plates dried semi-weekly.
3. Distilled water with air agitation.
4. Distilled water with air agitation, plates dried semi-weekly.
5. Ten per cent salt brine at rest.
6. Ten per cent salt brine at rest, plates dried semi-weekly.
7. Ten per cent salt brine with air agitation.
8. Ten per cent salt brine with air agitation, plates dried semi-weekly.

In all experiments three plates were used, but it should be recorded that the difference in appearance between different plates from the same experiment and also the differences in weights at different periods were very slight.

All of the No. 4 experiments were carried out in the ordinary diffused light of the chemical laboratory and at ordinary room temperatures, which for the most part ranged between 68 and 72 deg. F. but might go occasionally to 90 deg. F. in summer. The plates were suspended from wooden rods by means of strings attached through a ¼-in. hole into several earthenware jars. The air used for agitation came from the laboratory compressed air system (from a compressor) and no special means were used for washing it. The air was conducted to the bottom of the jars by means of a single glass tube and a moderately rapid stream of bubbles was kept passing through the liquid day and night, sufficient to agitate it slightly and keep it saturated. The agitation undoubtedly did increase the corrosion to a certain unknown extent.

Prior to weighing them, the plates were cleaned with an ordinary scrubbing brush, which was sufficient for the removal of any flocculent or loosely adherent rust but which did not remove rust adhering tightly to the metal surface. At the conclusion of the experiments (1,000 days) the plates were weighed after this method of cleaning, again after being cleaned with a stiff wire brush, and a third time after sand blasting.

Before sand blasting was used as a means of cleaning the adherent rust and scale from the plates, careful experiments were made as to the conditions under which this removal could be brought about without actually taking off any appreciable amounts of the metal itself. Conditions were ultimately established which resulted in the removal of all the scale without the removal of enough of the metal beneath to affect the results. Prior to the adoption of sand blasting as a means of cleaning the plates, various other means were attempted but without success. One method was partly successful—namely, dipping the plates first in fatty acids heated to the smoking point followed by a rinse of hot water and immersion into boiling, strong caustic soda solution. This treatment removed rust and scale in some cases, but was not by any means certain in its action. Hydrochloric acid and antimony trichloride in various proportions were also tried, but this means did not prove effective. Then the sand blast was applied.

All the experiments were continued for 1,000 days with the exception of those plates which disintegrated and fell apart prior to that time. The charcoal iron plates corroded so rapidly that they were not experimented with beyond 500 days.

After the cast plates were sand blasted the surface was ground off by means of an emery wheel, thus reducing the thickness of the plates somewhat and removing the silicon surface, if any. These plates were then replaced in water and brine and subjected to the same conditions as before. These experiments are now in progress. When completed, this series of experiments will furnish a comparison between the course of corrosion in the case of untreated cast-iron surfaces and cast iron with the original silicon surface removed.

### Brine Solution

The brine used was a 10 per cent solution of sodium chloride in distilled water made up from a pure grade

of commercial salt and maintained at 10 per cent strength by suitable control periodically. Heyn and Bauer[3] and also Friend and Brown[4] have shown that the concentrated solutions of many salts (and inferentially perhaps most) are capable of reducing the amount of corrosion of iron or of inhibiting it altogether. These experimenters made use of one condition of corrosion only, and carried out their experiments by submerging the iron in a solution which was quiescent and whose surface was exposed to the air.

The fact that salt brine retards corrosion when iron is submerged and air only brought in contact with it by the slow process of diffusion from the surface of the liquid, is borne out in the Series 4 experiments; but for other conditions, particularly when air is used for agitating the liquid and when drying is resorted to, the rule is not borne out. The results clearly show that brine is not the determining factor. Friend has shown that NaCl solutions at ordinary temperatures and in the absence of air (oxygen) exert no appreciable action upon iron. If the results obtained with quiescent water and brine detailed below are considered, the suspicion seems warranted that atmospheric oxygen is still the controlling influence, since gases are generally less soluble in salt solutions than in pure water.

After the Series 4 plates were removed from the corrosion experiments at 1,000 days (500 days in the case of charcoal iron, Sample XX) their appearance was carefully observed.

### Appearance of the Series 4 Plates

A certain uniformity in appearance prevailed in the case of all plates exposed to the same conditions of corrosion. For example, all of the plates under condition 1, water at rest, not dried, had a clean surface without mill scale or adherent rust. The same was true for condition 5, brine at rest, not dried. Under condition 3, water with air agitation, not dried, generally the surfaces remained clean. In some instances mill scale remained to the last and there was a strong tendency toward pitting, especially where mill scale had adhered or rust attached itself more firmly than usual. Condition 7, brine with air agitation, not dried, also preserved the surfaces clean as a rule and likewise showed a tendency toward pitting. Condition 2, water at rest, dried, left the surfaces covered with tightly adherent magnetic oxide of iron which in some instances produced fine pitting. Condition 6, brine at rest, dried, did not produce the magnetic oxide surface on the rolled metals but, on the other hand, the rolled plates under this condition were partly clean and partly covered with reddish brown rust. In some cases the surfaces were nearly clean and in numerous cases especially among the cast metals there was pitting action. Under condition 4, water with air agitation, dried, the plates were, as a rule, badly attacked. Some of the rolled sheets were corroded away entirely and the cast metals were frequently deeply pitted. In many cases deep pits and holes prevailed. Condition 8, brine with air agitation, dried, on the whole perhaps caused greatest corrosion in the majority of cases, although condition 3, water with air agitation, not dried, also produced great losses. In the latter case (water with air agitation not dried) a clean surface was generally maintained throughout, as noted above, while the oxygen acted as a depolarizer. In the case of condition 8, brine with air agitation, dried, while adherent rust formed during the drying operation, this was lifted in some cases and removed by the brine, or perhaps it did not adhere closely enough to the metal to afford protection. At any rate, the behavior of the adherent rust was decidedly irregular under this condition on the different samples.

### Corrosion in Water at Rest, Plates Not Dried

Corrosion as measured by loss of weight proceeds at a very regular rate, the plotted losses producing nearly straight lines without appreciable irregularities. So far as oxygen is concerned in corrosion of this sort, it must enter the water by the slow process of diffusion and solution from the air. The rust formed is loose and flocculent and, if at all adherent, easily removed by a soft brush. The losses in weight are, with one exception, greater than in the case of 10 per cent brine without air agitation and without drying. The corrosion in this instance shows a break between 400 and 500 days as though scale had formed and fallen off. This is the only instance of such an irregularity in any sample and, whatever the cause, undoubtedly accounts for the results.

The cast metals behaved very much like the rolled metals, but it is very noticeable that on the average the losses from the cast metals were greater than in the case of the rolled metals. (See Table IV.) There is one exception to be noted—namely, the two samples of puddled iron, which showed higher losses than any other rolled metal and also higher than any of the cast metals. It would appear from these results that when the ordinary types of iron and steel corrode under water at rest the corrosion follows in general what would be expected from the electrolytic theory on the basis of composition apart from any marked influence by rust and that the more impure metals corrode most. Even this generalization, however, fails to hold good in particular cases. Thus, while the average loss from the cast metals at 1,000 days is 29.4 g. and the average of the rolled metals, with the exception of the puddled iron, 24.6 g., two samples of open-hearth pure iron show greater losses than the average, whereas from their purity one might expect that they should show the least loss of all. Impurity is a general term, much too general, apparently, for the present discussion. One malleable iron high in graphitic carbon shows a higher rate of corrosion than the one which is low in graphitic carbon. Thus it is not easy to arrive at generalizations in regard to corrodibility as related to composition even in the simplest case of metals corroding under water in a quiescent state and hence with the influence of atmospheric oxygen reduced to a minimum.

Above all it should be emphasized that the most important distinction between this series of tests and the others is the absence of adhering rust.

### Corrosion in Brine at Rest, Plates Not Dried

Adherent rust made its first appearance here, although in the case of the cast steel samples only, consequently the weights after light brushing, after hard brushing and after the blast were equal except in these two cases. It has been commonly supposed that brine and other electrolytes were necessarily accele-

[3] "Ueber den Angriff des Eisens durch Wasser und wasserige Lösungen," *Mitt. kgl. Material-prufüngsamt*, Berlin; 1910, vol. 28, p. 62; 1908, vol. 26, p. 2.

[4] "The Action of Aqueous Solutions of Single and Mixed Electrolytes Upon Iron," read before the Iron and Steel Institute, London, May 11, 1911. An excellent digest of Heyn and Bauer's experiments and also those of Friend and Brown may be read in J. Newton Friend's "The Corrosion of Iron and Steel," Chap. 9.

tors of corrosion and there is evidence to support this view, particularly under atmospheric conditions when alternate wetting and drying occurs. At any rate this view has become current in spite of the demonstration of the contrary fact by Heyn and Bauer and Friend and Brown under such conditions that the iron was submerged in solutions of various strength, the only access of air being through the liquid surface. The results set forth in Table IV can perhaps best be explained by the fact that air and oxygen are less soluble in solutions of salt brine than in pure water. If oxygen is the determining factor in corrosion taking place under water and under brine, both in a quiescent state, the results could be explained by the relative solubility of oxygen.

### Corrosion in Water With Air Agitation, Plates Not Dried

The enormously increased corrosion which occurs on submerged plates when the liquid is kept saturated with air is prominently shown in Table IV. Generally speaking, the results are less regular than in quiescent water or brine, and are strongly suggestive that the final results are a compromise between different factors or a resultant of various forces acting in some cases in contrary directions.

All of these samples show evidence of pitting action. In the rolled sheets this is due to a great extent to mill scale which adheres tightly in localized areas. Some of the rolled sheets, notably DD, puddled iron, were badly perforated with holes varying from $\frac{1}{8}$ in. to $\frac{3}{4}$ in. in diameter. A few of the other samples of rolled metal show pitting and some great corrosion along the edges, producing a deeply serrated or lace-like margin.

The cast plates also showed pitting, but another prominent characteristic of these was the development of pimples, cones and craters on the surface. The formation of pimples was due to the separation of a film of oxide from the surface of the metal, presumably by gas. Underneath such a pimple a pit was formed. The cones and craters were formed in the usual manner by the movement of rust with the electrolytic currents as described by Cushman and Gardner.[5]

In general, the rolled metals show a more uniformly large amount of corrosion than do the cast metals. However, the two cast steel samples show the highest amount of corrosion of any. Thus the two most impure metals of the entire lot show the least corrosion under air-agitated water. They also show no adherent rust. The cast iron and semi-steel samples are the ones which suffered least corrosion and these metals are both distinguished by a high percentage of graphitic carbon and a high percentage of silicon.

Obviously composition is not in itself and directly the determining factor here. Oxygen undoubtedly is, but with this fact admitted, more light is needed on the behavior of the various cast metals, since they show such great variations in corrodibility, and also on the reasons for the rather uniform and high rate of corrosion in the rolled metals.

The failure of the gray cast irons and the semi-steels to corrode as rapidly as the purer rolled metals or the cast steels in the presence of oxygen but with rust for the most part absent opens a wide line of questioning and tempts one to make hypotheses. Is it possible that we are dealing here with a mild form of passivity such as might be induced by the action of oxygen on the iron surfaces causing them to become electro-negative to the graphitic carbon? If we suppose the graphitic carbon in the cast metals to be electro-positive to oxides of iron, then possibly the ordinary direction of current under corrosion from iron to iron oxides would be modified and there would be no corrosion. In a succeeding paper the experiments on solution of iron in acids[6] show that solution in nitric acid is comparable to corrosion under air-agitated water, whereas solution in sulphuric acid is comparable to corrosion under quiescent water.

To generalize and put the matter in brief form, the purer the metal the greater is the accelerating influence of oxygen and oxidizing agents (provided they do not induce passivity) in corrosion.

### Corrosion in 10 Per Cent Salt Brine With Air Agitation, Plates Not Dried

Under this condition all types of metal used showed less corrosion than under air-agitated water, with the exception of the two samples of gray cast iron and the two samples of semi-steel. However, even in the case of these two types of metal, the pitting action shown by practically all the plates under air-agitated water was not in evidence. Generally speaking, all of the plates under agitated brine presented a fairly smooth, clean surface, finely crystalline in appearance in the case of the rolled metals and granular in the cast metals. The edges were not serrated and little mill scale or strongly adherent rust was present. In a few cases rust did adhere, but this was the exception.

It is noticeable that in general those samples of the cast metals which corroded most under air-agitated water also corroded most under air-agitated brine. The cast steels reversed themselves in a peculiar way. These comparative rates of corrosion are not casual or accidental. The appearance and the weights of the three different plates used in each case were very nearly the same. Although the influence of the composition apparently makes itself felt indirectly through the medium of oxygen and of rust, nevertheless the course of corrosion for a given metal is definite and not variable except as the conditions are varied.

### Corrosion in Water at Rest, the Plates Being Dried Semi-Weekly

The characteristic thing about these plates was the tightly adherent coating of black magnetic oxide of iron which formed shortly after the mill scale came off and persisted throughout the experiment. The exceptions were not numerous. Among the rolled metals there were but two—namely, DD and EE, puddled irons. The surface in the case of DD was mottled red and brown, with exposed surfaces of iron showing through in small irregular areas of the darker rust. In EE the appearance was similar but with rather more of the black oxide in evidence. All of the other rolled sheets, including the charcoal iron, were uniformly covered with the adherent layer of black oxide. In some samples the pimples and blisters were more in evidence than others. The coating was as a rule uniform, of moderate thickness and with a dull, lusterless surface, which in some cases presented a pimply appearance.

The cast metals differed from the rolled sheets in showing a tendency in some cases toward the production of reddish or reddish-brown rust instead of the black

[5] Corrosion and Preservation of Iron and Steel, pp. 57-61.

[6] Ratio of solution of iron and steel in non-oxidizing and oxidizing acids.

magnetic oxide layer, and on the other hand, toward the production of the black layer in quiescent brine, dried.

Apparently the black oxide forms underneath the red oxide and may be a reduction product of the latter, the reducing agent being electrolytic hydrogen, according to the following equation: $3Fe_2O_3 + 2H = Fe_3O_4 + H_2O$. Or it may be due to a combination of FeO with $Fe_2O_3$. The black oxide layer was observed occasionally under other conditions besides in quiescent water, dried, and in quiescent brine, dried, but to a less extent.

A glance at Table IV indicates at once the comparatively small amount of corrosion in water as contrasted with brine, particularly in the case of the rolled sheets (columns 5 and 6). A rather adherent type of rust is indicated, inasmuch as no more was removed in any case by rather severe brushing with a wire brush than by a soft brush. The average loss in the case of the rolled metals before sand blasting amounted to 20.7 g. and of the cast metals 16.2. After cleaning the plates by sand blasting, the average loss in the case of the rolled sheets was 41.1 and in the case of the cast metals 31.7. The black oxide appeared to cling much more tightly to the rolled metals than to the cast metals as a whole—in fact so closely that in most instances it appeared as though it had become a part of the metal itself—and in sand blasting it was difficult to decide when the scale was entirely removed and the metal uncovered and how long the blasting should be continued for the removal of the oxide without affecting the metal beneath. There can be no question about this layer of oxide acting as a protective covering for the iron in these cases.

The two samples of cast steel, PP and QQ, behaved like the rolled metals and showed the black layer under water and reddish brown under brine, thus showing once more a similarity in corrosion behavior to the rolled metals which will appear again in several instances below. On the other hand, the gray cast-iron samples showed their unlikeness to the rolled metals and the cast steels in this instance as in others.

### Corrosion in 10 Per Cent Salt Brine at Rest, the Plates Being Dried Semi-Weekly

The appearance of all of the plates under this condition was decidedly different from that discussed just above. The rolled sheets were not covered with the black oxide coating so characteristic of similar plates held under water and dried semi-weekly. Now the rolled metal plates remained partly clean and partly covered with a typical reddish brown rust. Much of the rust could be removed with a soft brush and practically all of it with a wire brush, so that it was not necessary to resort to sand blasting. There was little pitting in any of the rolled sheets, the deepest occurring in the two samples of puddled iron, DD and EE. The charcoal iron showed no pitting.

Among the cast metals the most severe action occurred in the case of the two samples of cast steel, particularly PP, and this action was evident to the eye in the form of broad deep pits and holes. Sample FF, gray cast iron, showed slight pitting action, while SS showed less. Samples LL and OO, white cast irons, were both pitted, but both lost much less weight than samples MM and NN, malleable irons. The iron losses were comparable to those of the gray cast irons and semi-steels. GG, semi-steel, was uniformly pitted over the entire surface and presented a pock marked appearance, whereas RR showed larger areas of corrosion. Both, however, lost practically the same amount of metal. The average loss by the cast metals with the exception of the two cast steels was much less than the loss sustained by the rolled sheets. The two samples of cast steel lost an average of 189.1 g., greater than that of any other sample. One sample of common open-hearth iron, UU, showed the greatest loss among the rolled metals, 176.8 g., approaching the average of the cast steels and greater than QQ sample of cast steel.

The influence of the products of corrosion in causing pitting action and also in producing a protective coating is illustrated among the cast metals. The rust on the two samples of gray cast iron adhered very tightly, as shown by the fact that these plates exhibited no loss in one case and only 2.1 g. in another when scrubbed with a soft brush. Treatment with a wire brush removed a considerable amount of rust and sand blasting a still larger quantity, although the final loss was comparatively low. The same holds true for the two samples of semi-steel.

### Corrosion in Water With Air Agitation, the Plates Being Dried Semi-Weekly

All samples were more or less covered with reddish brown rust. In some cases this was tightly adherent in spots. In others it was spongy. The rolled metals were much more severely attacked as a whole than the cast metals, the only cast metals approaching them in pitting effect and general corrosion being the two samples of cast steel.

Of the two copper-bearing mild steels, one, AA, was destroyed altogether, that is, it was so badly pitted and corroded that there was not enough metal left toward the last to permit of its being continued in the experiment, whereas CC, while badly pitted and suffering from general corrosion, held together much better. This is an interesting case, since the composition of the two kinds of metal is very much alike. Nevertheless, due to some unknown factor (possibly physical treatment) one suffered from corrosion and disintegration much more than the other. Needless to say, both would have failed in service long before 1,000 days. The losses of the copper-bearing metals were greater than those of any other samples of rolled metal.

Samples BB and II, representing typical open-hearth pure irons, presented an almost identical appearance, being badly pitted and full of holes, but in sample BB the corrosion was obviously greater and the loss is greater too. Samples JJ and KK, representing cold rolled open-hearth pure irons, suffered considerably less loss than the two black samples, probably owing to the accelerating effect of mill scale in the latter cases and to the protective action of rust which adhered more tenaciously in the former. The samples of ordinary open-hearth iron, UU and WW, on the average lost somewhat more weight than samples BB and II, and sample WW in particular did not hold together so well. Sample UU, however, at the end of the experiment presented a better appearance than either BB or II and was less pitted and showed fewer holes. On the other hand, WW exhibited weaknesses apparently due to uneven composition or bad mechanical treatment. The two samples of bessemer iron, TT and VV, did not do as well as the open-hearth samples, VV being entirely gone before 1,000 days, although its true condition was concealed during most of the experiment by adherent rust. These two samples (TT and VV) afford an

interesting contrast. TT was badly attacked as shown by loss of weight, whereas VV, judged by loss of weight during the course of the experiment, showed scarcely greater losses. Both were rather heavily coated with rust, but the processes of corrosion had gone on under the rust covering of VV to a much more insidious extent than under the rust of TT, so that at the end of the experiment sample VV crumbled away, while TT still retained enough metal to hold it together.

Of the cast metals, all but the two cast steels held up in a remarkable manner throughout the test, although all showed evidence of pitting action. The two best in

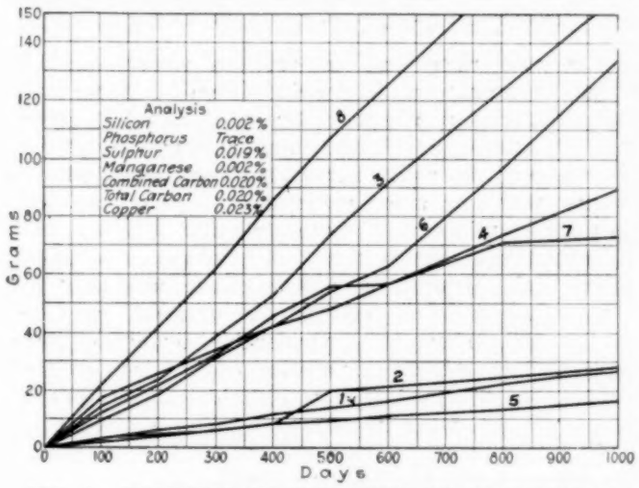



FIG. 1. PROGRESS OF CORROSION IN COLD-ROLLED OPEN-HEARTH INGOT IRON, SILICON 0.002 PER CENT[1]

appearance were the two gray cast irons, with the two semi-steels running a close second. The white irons and the malleable irons were about alike in appearance, although the malleable samples lost more than the white irons. The two cast steel samples lost more than any other of the cast metals but less than most of the rolled sheets. They were, however, badly pitted and showed every evidence of the worst sort of corrosion such as results in early failure.

### Corrosion in 10 Per Cent Salt Brine With Air Agitation, the Plates Being Dried Semi-Weekly

Judging by the appearance of the plates and the losses, this was the severest condition of all. As immediately above, all plates were covered with reddish brown rust which showed different degrees of adhesion in the case of different samples. Speaking of all the plates, the chief difference perhaps between those from brine and from water was the larger pits and holes produced in the former.

Several of the rolled sheets were entirely disintegrated before 1,000 days. Two of the three plates (WW), while very thin, showed no deep pitting action. The third was more severely attacked and exhibited pits and holes. Sample DD, puddled iron, was entirely disintegrated prior to 1,000 days. EE, being thicker and also because corroding less, lasted through the experiment and while badly corroded showed less pitting action than some other samples. The fibrous structure of the metal, however, was emphasized by the corrosion, the pits running longitudinally and parallel with the fibers. Sample XX, charcoal iron, showed less loss in brine than in water.

The cast metals were all pitted with deeper and wider pits than under water. Sample FF, gray cast iron, was perforated in several places, whereas sample SS, while suffering practically the same loss, was not. Of the two cast steels, PP was very severely attacked, being perforated with large holes and exhibiting wide and deep pits. The pits in QQ were also very wide but there were fewer perforations and the loss of metal was much less in this case.

It is a most difficult matter to draw any conclusions from these experiments which correlate composition and corrosion. Gross mechanical and physical differences undoubtedly invite corrosion, as can be seen by inspection of the cast metals, but on the other hand extreme purity and uniformity (in the sheet metals) do not protect against corrosion. The less pure metals on the whole resisted corrosion under intermittent action of air-saturated brine better than the purer, the best samples being in order the white cast irons (average loss 151 g.), the semi-steels (average loss 191 g.) and the gray cast iron (average loss 196 g.). Malleable iron MM with the lower carbon content lost much more (237 g.) than NN with the higher carbon content (192 g.). This is what would be expected from a comparison of the cast and rolled metals in respect to carbon content.

Charts have been plotted showing the history of the various pieces, upon the basis of successive weighings of brushed plates. Of these charts, Figs. 1 and 2 only are reproduced, showing the progress of corrosion in cold-rolled open-hearth ingot iron and in gray cast iron. Figures on the graphs represent the condition of immersion, as noted in the columns of Table IV.

When one considers the small amount of corrosion which occurs in the case of gray cast iron compared with that which occurs in the case of the much purer rolled

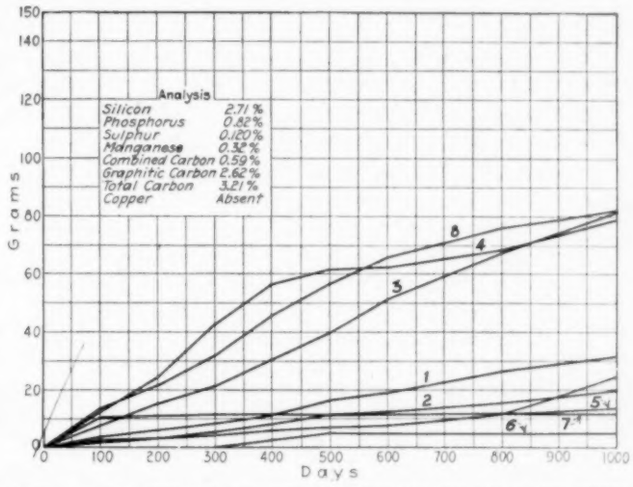



FIG. 2. PROGRESS OF CORROSION IN GRAY CAST IRON, SILICON 2.71 PER CENT[1]

metals and particularly the pure open-hearth iron, an investigator may be forgiven for becoming a skeptic on the subject of the electrolytic theory of corrosion as it has sometimes been presented in the past. An addition to the theory is required to explain why gray cast iron with its considerable percentage of impurities should corrode rather less than other and purer metals. That adherent rust protects it to a considerable extent can scarcely be doubted, but that this is the only protective influence it would be unsafe to say at present. Cast iron corrodes with a fair degree of rapidity under several conditions, but a glance at the curves, which are very similar for both FF and SS, reveals a strong

[1]Numbers refer to the conditions of the experiment shown in Table IV.

TABLE IV. CORROSION LOSSES IN GRAMS, AFTER 1,000 DAYS, DETERMINED ON SAND-BLASTED PLATES

| | | — Plates Continually Wet— | | | | Plates Dried Semi-Weekly | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Quiescent | | Air-Agitated | | Quiescent | | Air-Agitated | |
| Mark | Kind of Iron | Water 1 | Brine 2 | Water 3 | Brine 4 | Water 5 | Brine 6 | Water 7 | Brine 8 |
| AA | Copper bearing | 22.7 | 18.0 | 177.5 | 110.6 | 45.9 | 131.1 | *a* | *a* |
| CC | Copper bearing | 23.0 | 19.0 | 184.9 | 111.2 | 36.8 | 153.9 | 204.2 | *a* |
| BB | Open-hearth pure iron | 28.4 | 21.5 | 160.8 | 111.6 | 51.2 | 145.7 | 164.8 | *a* |
| II | Open-hearth pure iron | 26.6 | 27.9 | 155.4 | 89.7 | 48.5 | 133.5 | 148.7 | 247.9 |
| JJ | Ditto cold rolled | 24.1 | 16.4 | 223.1 | 128.5 | 41.3 | 107.2 | 124.3 | 253.0 |
| KK | Ditto silver finish | 24.1 | 14.1 | 192.0 | 114.4 | 41.5 | 129.2 | 132.7 | *a* |
| UU | Open-hearth iron | 21.3 | 12.2 | 188.6 | 95.9 | 51.1 | 176.8 | 146.5 | *a* |
| WW | Open-hearth iron | 23.8 | 15.9 | 215.5 | 102.3 | 49.9 | 147.3 | 186.6 | 221.9 |
| TT | Bessemer iron | 29.5 | 14.1 | 178.4 | 96.8 | 53.5 | 161.8 | 171.0 | 252.1 |
| VV | Bessemer iron | 23.2 | 16.9 | 230.7 | 101.6 | 50.3 | 153.8 | *a* | 222.6 |
| DD | Puddled iron | 39.1 | 24.1 | 196.6 | 102.1 | 65.6 | 151.9 | 143.1 | *a* |
| EE | Puddled iron | 36.8 | 20.3 | 233.7 | 108.4 | 43.9 | 111.9 | 107.9 | 305.3 |
| XX | Charcoal iron (500 days) | 21.6 | 11.4 | 152.9 | 70.6 | 33.8 | 90.6 | 189.4 | 160.3 |
| FF | Gray cast iron | 31.1 | 19.9 | 78.8 | 88.1 | 24.4 | 95.0 | 62.9 | 196.6 |
| SS | Gray cast iron | 28.6 | 22.3 | 103.4 | 143.5 | 32.8 | 57.2 | 42.0 | 195.5 |
| LL | White cast iron | 27.2 | 24.5 | 230.7 | 116.2 | 13.6 | 70.9 | 51.4 | 153.8 |
| OO | White cast iron | 29.6 | 18.1 | 144.1 | 103.0 | 24.8 | 65.5 | 59.7 | 149.9 |
| MM | Malleable iron | 23.8 | 17.8 | 222.2 | 118.5 | 31.6 | 130.2 | 63.1 | 237.6 |
| NN | Malleable iron | 30.5 | 19.5 | 218.3 | 113.1 | 39.5 | 103.6 | 86.5 | 191.9 |
| GG | Semi-steel | 33.9 | 20.5 | 97.3 | 124.0 | 33.2 | 81.5 | 62.1 | 192.6 |
| RR | Semi-steel | 28.8 | 18.5 | 118.6 | 124.5 | 25.2 | 81.4 | 48.1 | 189.2 |
| PP | Cast steel | 30.6 | 24.4 | 242.2 | 107.4 | 55.5 | 218.0 | 120.7 | 447.7 |
| QQ | Cast steel | 29.2 | 24.9 | 247.6 | 78.5 | 36.2 | 160.3 | 122.3 | 285.9 |
| | Aluminum (905 days) | 0.0 | 0.1 | 0.4 | 0.2 | 0.0 | 0.8 | 0.1 | 0.5 |
| | Copper (905 days) | 0.1 | 14.0 | 0.3 | 12.4 | 0.1 | 8.3 | 0.7 | 10.0 |

*a* Metal disintegrated.

tendency for the upper group of three to bend toward the horizontal due to the adherence of rust which when removed gives them a sharp turn upward.

### Corrosion of Aluminum and Copper

In order to obtain a comparison between aluminum and copper, rolled plates of each of these metals, 16 gage, were subjected to the same corroding influence as the samples of iron in the No. 4 series of experiments and the results are tabulated in Table IV. The aluminum plates used contained 0.08 per cent copper, 0.50 per cent silica and 0.29 per cent iron.

The aluminum plates lost practically no weight worth mentioning under any of the eight conditions, although there were definite signs of corrosion in some instances, particularly in 10 per cent brine in the form of white deposits, at various points on the plates and a few deep pits.

It has been stated by Walker[5] that "the aluminum oxide coat on metallic aluminum effectually protects the metal and practically prevents further corrosion." This does not appear to be the case (unless the oxide layer is submicroscopic or of a passive nature), since much of the original metallic polish or luster remained on the aluminum plates in the above experiment to the last, particularly those in water.

It is needless to point out that copper is strongly electro-negative to aluminum and on the basis of the electrolytic theory, which takes into consideration solution tension alone, aluminum should corrode much more rapidly than copper and also more rapidly than iron, but solution tension is only one factor in corrosion and in some cases a very minor factor.

The copper plates lost more in water with air agitation than without, although the losses in both cases were very small. In brine the losses were much greater but were less when the samples were dried than when not dried, thus suggesting a slight protective action of the products of corrosion in the case of the dried samples.

If we consider that oxygen accelerates corrosion merely by removing the hydrogen film produced by solution pressure in the first instance, it is difficult to see why the corrosion of aluminum should proceed at so much slower a rate than iron and doubly hard to understand why the corrosion of copper should proceed at a more rapid rate than that of aluminum. There is the possible explanation that iron and copper catalyze the oxygen-hydrogen reaction more than does aluminum or that the ferric hydrate (rust) produced catalyzes this reaction, but there appears to be more than this involved in the different behavior of the three metals, aluminum, iron and copper.

[5] *Scientific American*, vol. 122, p. 110, January, 1920.

## Storage of Gas for Reserve

By Brigadier-General Amos A. Fries

A complete report has been rendered recently on tests of gas in storage at Edgewood Arsenal. Those tests show that for phosgene, chlorpicrin, chlorine, silicon and titanium tetrachlorides, and mixtures of stannic chloride and chlorpicrin there has been practically no change whatever since manufacture, though all have been kept a minimum of twenty months.

Mustard gas has shown a little increase in hydrochloric acid, though not nearly the amount that had been anticipated. Of still further interest, very few of the gases show any considerable amount of iron, indicating that the deterioration of the iron or steel drum in which kept is also very slight. Unquestionably there will be much more combination with iron in artillery shell where the area of the iron compared with the total amount of gas is greater.

There are still on hand many thousands of gas shell that are being gradually tested. These will afford direct evidence of the extent to which iron is corroded or taken up by the different gases. The whole tendency at present it toward the belief that gas may be kept in shell from two to five years without sufficient deterioration to make them unusable. This is highly important as showing the amount of reserves of gas that a nation may accumulate prior to the beginning of hostilities, as well as the furnishing of gas shell to far distant bases that might be cut off from help for a year or more.

Sulphur monochloride, which is used in the manufacture of mustard gas, due to the readiness with which it hydrolizes to form hydrochloric acid in the presence of air, is so corrosive as to make its storage more difficult even than that of mustard gas itself.

Chlorine can be kept apparently indefinitely, though all valves must be very carefully watched, as they corrode very rapidly. This is due, of course, to the formation of hydrochloric acid where moist air reaches the chlorine.

Phosphorus, which has very great possibilities as an active offensive agent due to its burning properties, either wet or dry, can be kept indefinitely by being totally submerged in water. The large quantity on hand in cans at Edgewood Arsenal when the armistice was signed has all been dumped into concrete tanks kept filled with water.

## Scarcity of Newsprint Paper in Ecuador

It is reported that the high cost as well as the scarcity of newsprint paper in Ecuador has occasioned an advance in the selling price of two Guayaquil dailies from 5 to 10 centavos (1 centavo = $0.0048) per copy for the public, and from 3 to 7 and 9 centavos for newsboys. A decline in circulation resulted.

## Carbon-Free Ferronickel in a High-Frequency Induction Furnace

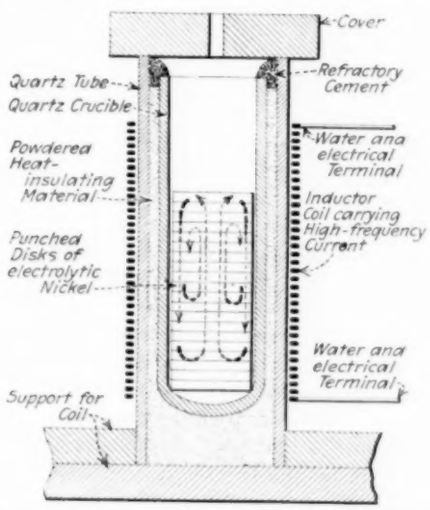
BY DUDLEY WILSON

Commercial melts have been regularly made of a ferronickel alloy, which it was essential to melt and mix without the addition of any carbon, a difficult feat in any of the older standard furnaces.

A quartz crucible was used about 1¾ in. in inside diameter and 8 in. long, as shown in the diagram. Disks punched from sheets of electrolytically deposited nickel were then stacked up in the tube and the heating current induced directly in the disks. The iron was added in small pieces after the nickel was melted. Material to the amount of 2,000 g. (4.4 lb.) was melted down in this manner and then poured into a mold ¾ in. in inside diameter and 20 in. long.

The ingredients of the alloy were thoroughly mixed by the stirring action of the current indicated in the figure by dotted arrows. This stirring is caused by the action of electromagnetic forces in the molten metal during the time the power is on the furnace.

Care was taken to pour the melt immediately after the current was thrown off. The metal was heated only a few degrees above the melting point; it was found very desirable to pour the metal without superheating it more than necessary. If the metal is highly superheated and then poured, small crystals formed on the surface due to the chilling action of the mold, and upon solidification the crystals become gradually larger toward the center of the rod. When the metal was poured without superheating the crystalline structure was practically uniform because the metal solidified at the center nearly as rapidly as at the surface. As is perhaps well known, it is very difficult to accomplish thorough mixing of




FURNACE FOR PRODUCING CARBON-FREE FERRONICKEL

alloys without high superheating in the ordinary type of arc or resistance furnace. When the resulting bars were analyzed it was found that there was less than 0.01 per cent difference in composition between the material in the two ends of the rod, indicating that the mixing of the alloy was exceedingly thorough.

It will be seen by referring to the sketch that no carbon is used in this arrangement of the furnace. Hence it is certain that no carbon is added to the metal being melted. It is believed that no other furnace could accomplish such a result.

The time for the entire cycle of operations necessary for charging, melting and pouring was 40 minutes. Starting cold, the heating and melting required 20 minutes, drawing 12 kw. from the service lines. Many melts in work extending over several months have been made with uniformly successful results.

Trenton, N. J.

## The Sugar Situation in New Zealand

The Minister of Agriculture of New Zealand has announced that the contract entered into three years ago between the New Zealand Government and the Colonial Sugar Refining Co. expired on June 30, 1920. As a result of the very favorable terms obtained by the government, sugar has been retailed in New Zealand at 5@7c. a lb. both during the war and since, but when the dominion goes into the open market for sugar the retail price is expected to advance to about 12c. It is claimed that the wholesale price will be about $146 per long ton, instead of $116, the price paid during the present year.

# Synopsis of Recent Chemical & Metallurgical Literature

**The Composition of Kiln Gases and Their Effects on Terra Cotta Glazes and Colors.**—The minor chemical reactions which may take place throughout the kiln and reasons for unsatisfactory results therefrom are treated in the notes on investigations made by F. B. ORTMAN in the June issue of the *Journal of the American Ceramic Society*. The work was carried on over a period of months on several different terra cotta kilns of the usual round, up-and-down draft, muffle type.

Sulphuring is one of the most frequent sources of trouble and analyses of finished glazes show it is actually held in chemical combination. This comes not from the enamel material but from sulphates and pyrites in the clay ware and the combustion gases from the coal.

The effect of ventilation on the $SO_2$ in the kiln experiments resulted in the following conclusions:

First. That there exists within the kiln chamber, in contact with the ware, an appreciable amount of $SO_2$ gas practically from start to finish of the burn.

Second. That the source of this is from a leakage of combination gases through the muffle wall, up until about red heat, when the sulphur begins to distill from the pyrites in the clay.

Third. That owing to the excessive ventilation prevailing at the beginning of the burn, the $SO_2$ is removed rapidly and does little damage.

Fourth. That after the glaze has fused it is not easily susceptible to chemical action of $SO_2$ upon its surface.

Fifth. That the danger zone, therefore, lies between red heat and the time of fusion of the glaze, and is particularly troublesome because the sulphur being distilled as $SO_2$ from the pyrites in the clay encounters a moist atmosphere due to the dehydration of the clay, forming $H_2SO_3$, and at a time when the ventilation is apt to be sharply reduced by the closing of trial holes and crown openings.

Sixth. The sulphuric acid gas thus formed may be taken up by the glaze, either by physical absorption or

chemical combination or both, and exert its destructive action.

The experiments with the effect of reducing conditions led to the following conclusions:

First. That it is impractical to depend entirely upon direct admission of air through trial holes or other openings for maintenance of oxidizing conditions, without retarding the progress of the kiln beyond practical limits.

Second. That after closing all the trial holes and other openings into the kiln the oxygen is consumed very rapidly.

Third. That the oxygen is consumed much faster when the gases of combustion are allowed to become reducing or near reducing.

Fourth. That once the oxygen has been exhausted in the kiln chamber it is difficult if not impossible to re-establish oxidizing conditions by admitting air into the combustion gases.

Fifth. That it is highly essential, therefore, that the combustion gases be kept safely oxidizing throughout, particularly after the trial holes are closed.

Sixth. That the setting up of reducing conditions, particularly after the glaze has fused, may produce blistering, scumming, etc., on glazed work, by reason of reduction of sulphates previously absorbed and liberation of $SO_3 + O$ through the molten glaze.

Seventh. That while the kind of coal, method of firing, construction of firebox and secondary air supply all have an important bearing on the maintenance of this condition, the first and most important factor is an adequate draft, without which, in the ordinary up-and-down draft muffle kiln, occasional reducing conditions are inevitable.

**Cadmium Production in 1919.**—There are now five concerns producing cadmium in the United States: A. S. & R. Co., Grasselli Chemical Co., Krebs Pigment & Chemical Co., Midland Chemical Co. and the U. S. Smelting, Refining & Mining Co., the last at two plants, Midvale, Utah, and Kennett, Cal. Several electrolytic zinc plants and lithopone plants save cadmium-bearing residues and have worked out processes for the recovery of the metal. An extension of the uses of cadmium and an increased demand for it would result in additional producers. Several companies that produce cadmium-bearing residues have sold their product to others equipped to produce the metal. This practice points the way to custom cadmium reduction plants handling the produce of companies the output of which is too small to justify individual reduction plants.

Two forms of cadmium are produced—the metal and cadmium sulphide, a pigment. The first cadmium was produced in the United States in 1906. During the next year the domestic production was nearly sufficient to supply the demand. The foreign supply has come largely from Germany, although a small amount has been produced at the electrolytic zinc plant of Brunner, Mond & Co. and Chance & Hunt, in England. The accompanying table gives the statistics of production for the United States and Germany from 1906 to 1919 inclusive.

In 1918 the U. S. Geological Survey made a canvass of lead smelters, electrolytic zinc plants, lithopone plants and a few typical brass works to ascertain the yearly recovery of cadmium in fumes and residues, the accumulated stocks of such materials and the maximum capacity of the cadmium reduction plants. Although the data obtained are not considered complete, they indicated that cadmium is being accumulated at lead smelters at the rate of 350 to 400 short tons annually and that the stocks of bag-house fumes contained more than 750 tons of cadmium. At electrolytic zinc plants about 200 tons is accumulating yearly and the stocks of residues contained about 400 tons. At lithopone plants probably 50 tons is produced annually and 25 tons is contained in stocks. This makes a total in round numbers of 600 tons yearly accumulation and about 1,200 tons in stocks on hand. From this it is estimated that 750 tons can be recovered from the stocks. As the production has been curtailed during 1918 and 1919 and has not materially increased during the first part of 1920, it is possible that the stocks have increased since the canvass was made in 1918. The maximum production capacity of refining plants reported by producers is 29,000 lb. per month, or about 175 tons a year.

METALLIC CADMIUM AND CADMIUM SULPHIDE PRODUCED IN THE UNITED STATES AND GERMANY, 1906-1919

| | United States | | | | | | Germany | | |
|---|---|---|---|---|---|---|---|---|---|
| | —Metallic Cadmium— | | | —Cadmium Sulphide— | | | Metallic Cadmium | | |
| Year | Quantity, lb. | Value | Average Price per lb. | Quantity, lb. | Value | Average Price per lb. | Quantity, lb. | Value | Average Price per lb. |
| 1906 | 300 | $300 | $1.00 | (a) | ..... | ..... | 47,368 | $36,083 | $0.76 |
| 1907 | 14,000 | 14,350 | 1.025 | (a) | ..... | ..... | 72,639 | 60,757 | 0.84 |
| 1908 | 8,000 | 6,000 | 0.75 | (a) | ..... | ..... | 72,741 | 48,590 | 0.67 |
| 1909 | 5,300 | 2,783 | 0.525 | (a) | ..... | ..... | 81,982 | 46,777 | 0.57 |
| 1910 | 4,700 | 2,585 | 0.55 | (a) | ..... | ..... | 90,516 | 39,309 | 0.43 |
| 1911 | 26,152 | 17,566 | 0.67 | 2,392 | $1,674 | $0.70 | 93,861 | 53,372 | 0.57 |
| 1912 | 52,508 | 39,875 | 0.76 | 8,998 | 6,400 | 0.71 | 94,262 | 63,507 | 0.67 |
| 1913 | 54,198 | 41,838 | 0.77 | 17,302 | 12,136 | 0.70 | 81,993 | 63,641 | 0.78 |
| 1914 | b 91,409 | 81,205 | 0.89 | 22,723 | 20,241 | 0.89 | (c) | ..... | ..... |
| 1915 | 91,415 | 108,443 | 1.19 | 10,624 | 12,057 | 1.13 | (c) | ..... | ..... |
| 1916 | 135,212 | 210,931 | 1.56 | 22,176 | 27,942 | 1.26 | (c) | ..... | ..... |
| 1917 | 207,408 | 305,097 | 1.47 | 50,169 | 70,939 | 1.41 | (c) | ..... | ..... |
| 1918 | 127,164 | 188,203 | 1.48 | 51,702 | 70,315 | 1.36 | (c) | ..... | ..... |
| 1919 | 99,939 | 121,926 | 1.22 | 31,197 | 37,436 | 1.20 | (c) | ..... | ..... |
| | 917,705 | $1,141,102 | ..... | 217,283 | $259,140 | ..... | ..... | ..... | ..... |

(a) No production.
(b) Exclusive of 4,225 lb. of cadmium in residues sold for export.
(c) No figures showing the cadmium production in Germany later than 1913 are available.

Cadmium is used in the metallic form chiefly in alloys, and the various salts are used in the arts, in medicine and in electroplating. In alloys it lowers the melting point and is therefore extensively employed in making easily fusible alloys and soft solders such as are used in fusible plugs of automatic sprinkler systems and in fusible safety plugs for boilers and electric fuses. Cadmium is also used as a substitute for tin in solders, but as yet such solders have not been used extensively.

Cadmium sulphide is used as a pigment and properly prepared is one of the most permanent yellow pigments known. As it is unaffected by hydrogen sulphide gas from coal smoke, it is employed for a protective coating over chrome-yellow in painting street cars and passenger coaches. The sulphide is also used to give color and luster to glass and porcelain. Other cadmium salts are used in dyeing, in dentistry and in photography.

Cadmium electroplating offers some promise of expansion, as it is a better rust preventive than nickel, and if prices were nearer parity, cadmium plating might be substituted for nickel plating in some cases. Or, since it has a greater tendency to tarnish than nickel, the first coat might consist of the rust-preventive cadmium and the second coat of the tarnish-proof nickel.

Abstracted from "Cadmium in 1919," by C. E. SIEBENTHAL, U. S. G. S., Mineral Resources of the United States, Part I.

# Recent Chemical & Metallurgical Patents

## British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

**Pyrogallol.** — Pyrogallol is prepared by heating gallic acid or tannin with an amount of a metallic compound not greater than twice that required to effect substitution of the hydrogen atoms of the carboxyl groups which are either originally present or are formed by hydrolysis. The metallic compounds referred to are the hydroxides, oxides, and weak-acid salts (e.g., carbonates and acetates) of the alkali and alkaline-earth metals, magnesium, aluminum, lead, copper and zinc. (Br. Pat. 140,691—1919. NITRIFABRIK AKT. GES., Coepenick, near Berlin, May 19, 1920.)

**Lignone Compounds, Tanning Agents.**—Halogenated lignone compounds and the like are obtained by treating with halogen or halogenating-agents, particularly chlorine, the waste liquors from the manufacture of paper by treating wood with bisulphites, alkalis, steam, etc., or waste liquors obtained in the retting of flax or other vegetable fibers. The waste liquors may be acidified and treated with steam before the treatment with halogen. In the case of bisulphite waste liquors, they may be given a preliminary treatment with alkalis or alkaline earths under pressure. The products can be obtained as extracts, pastes or dried powders, and may be used in tanning. (Br. Pat. 140,359—1919. PAPETERIES BERGES, Lancey, France, May 12, 1920.)

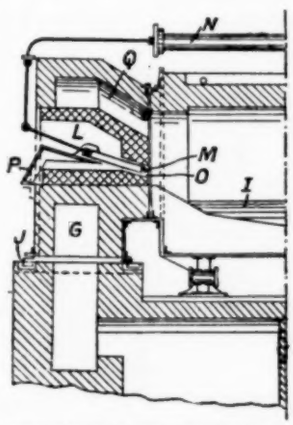
**Ozone.**—The yield on treating air, oxygen, etc., with silent electric discharges is increased by reducing the pressure of the air to below 550 mm. of mercury. Preferably, the reduction in pressure is combined with cooling of the air below —10 deg. C.; and it is particularly advantageous to work at a pressure of 400 mm. of mercury and a temperature of —100 deg. C. (Br. Pat. 140,777—1919. SOC. ANON. L'AZOTE FRANCAIS, Paris, May 27, 1920.)

**Acetaldehyde.**—In the production of acetaldehyde by passing acetylene into aqueous acid solutions containing a mercury catalyst, the activity of the catalyst is maintained by the addition of an oxidizing agent, particularly ferric oxide. The catalyst may be metallic mercury, reduced mercury, mercuric oxide, or a mercuric salt; it is mixed with ferric oxide, water and acid; preferably sulphuric acid of 30 to 35 per cent strength is used. The acetylene used should be purified, particularly from phosphoretted hydrogen; this may be effected by washing the gas with metal oxychlorides followed by a hydrochloric acid solution of mercuric chloride. The reaction liquid is maintained at 70 to 83 deg. C., the acetylene is passed in excess, and a mechanical agitator employed. Water is added at intervals to maintain the strength of the liquid, and the ferric oxide and sulphuric acid are also renewed at intervals. Instead of sulphuric acid, sulphonic acids, acetic acid, etc., may be employed. (Br. Pat. 140,784—1919. SOC. ANON. DE PRODUITS CHIMIQUES, ETABLISSEMENTS MALETRA, Petit-Quevilly, France, May 27, 1920.)

**Adhesives.**—The proteins contained in oilseed residues, particularly from hemp seed or castor beans, are extracted by dilute alkali, and the solution is either evaporated to dryness or precipitated by acid in known manner, and the dried extract or precipitate is converted into an adhesive by mixing it with one or more bases, such as an alkaline-earth hydrate or magnesia, and an alkali salt, such as sodium fluoride or arsenate, which is slowly decomposed by the base to give caustic alkali, and then mixing this mixture with dilute caustic alkali to form a stiff jelly. Instead of using the dry acid-precipitated proteins, they may be redissolved in caustic alkali and the solution evaporated to dryness and mixed with the ingredients mentioned above. (Br. Pat. 140,911—1919. M. O'GORMAN and S. B. SCHRYVER, London, May 27, 1920.)

**Lead and Silver Chlorides.**—Ores containing lead and silver which have been chloridized, for instance by heating with zinc chloride, are treated for the extraction of lead and silver by leaching with a hot brine containing ferric or cupric chloride or like agent to prevent the reversion of the chlorides to sulphides, and carrying out the leaching under conditions in which the time of contact of the solution with the ore is reduced to a minimum. Instead of adding ferric chloride or the like this agent may be formed *in situ* by adding a little hydrochloric acid to the leaching solution when the ore contains ferric compounds soluble therein. The leaching may be effected upon a continuously moving belt filter or upon filter beds having shallow layers of ore and provided with means such as suction or pressure for passing the liquor rapidly through the ore; or the ore mixed with leaching solution may be placed in a centrifugal machine, or the ore mixed with water may be placed in a centrifugal machine which is rotated until a cake is formed by the expulsion of the water, and the leaching solution is then added and the machine again rotated. (Br. Pat. 141,044—1919. AMALGAMATED ZINC, LTD., Melbourne, Australia, June 2, 1920).

**Open-Hearth Furnace.**—In an open-hearth furnace of the rocking or fixed type for melting metals, removable structures *G* of refractory material containing fuel and air supply ports are arranged at each end of the melting chamber *I*. Each structure *G* is mounted in recesses *J* containing sand arranged at the top of the regenerator, such recesses being sufficiently large to allow for displacement of the structure due to expansion of the furnace. One or more liquid fuel burners *M* are arranged on inclined guides *P* within a removable chamber *L* of refractory material and deliver fuel through the port *O* on to the hearth. The burners are supplied with fuel by a flexible pipe leading from a reservoir *N*. Air is supplied to the furnace from the port *Q*. When the burners are not in use they are withdrawn into the chamber *L*. The joints between structures *G* and the melting-chamber *I* are covered with layers of metal and asbestos. (Br. Pat. 141,055—1919. J. LAMBOT, Marcinelle, Belgium, June 2, 1920.)



OPEN-HEARTH FURNACE

# Current Events
## in the Chemical and Metallurgical Industries

### Minerals Separation, Ltd., Loses Another Appeal

On July 29 Judge Morris, in the United States District Court, Wilmington, Del., denied another appeal made in behalf of Minerals Separation for permission to file a supplemental bill charging Miami Copper Co. with renewed infringement. Arguments upon this application were made on July 26, just three days previously. Judge Morris' opinion denying this application is largely a quotation from his previous one in the Miami contempt proceedings (CHEM. & MET. ENG., July 21, 1920, pp. 90, 123) and is as follows:

> This case is again before the Court upon an application of the plaintiff for leave to file a supplemental bill charging the defendant with new acts of infringement since its discontinuance of the three processes heretofore adjudged to be infringements (244 Fed., 752).
>
> When considering the application heretofore made by the plaintiff that the defendant be adjudged guilty of contempt and/or that a further injunction be issued specifically enjoining and restraining the defendant from using the processes therein set forth I arrived at and stated the conclusion that "in view of the nature of the new processes used by the defendant as charged by the petition, the questions raised thereby, and the decision of the Circuit Court of Appeals in this case, 244 Fed., 752, I am of the opinion that the plaintiff must obtain the relief to which it is entitled, if any, touching the new processes, either through the proceedings now being had before the master and the decree to be entered thereon, or by a new bill and not otherwise. Which of these procedures is the proper one under all circumstances or whether both most be resorted to, one as to some of the processes and the other as to the remaining processes, need not now be determined." The words "new bill" were therein used to indicate a new original bill. I have considered the argument made in support of plaintiff's present application and find nothing therein justifying a conclusion different from that at which I arrived when considering the petition hereinbefore mentioned. The present application must, therefore, be denied.

### Canada Passes New Industrial Alcohol Bill

Since the administrative chairman made his report the industrial alcohol bill to amend the inland revenue act was passed by the House of Commons, and the manufacture of industrial alcohol has been stimulated considerably in the short interval since that time. The act provides for the sale of alcohol without the admixture of a denaturant and denatured alcohol and specially denatured alcohol, as defined in the act, free from excise duty. Such alcohol must be manufactured, denatured or specially denatured only in premises thereto licensed. Conditions are prescribed whereby specially denatured alcohol shall only be sold or delivered under a special permit to dealers and manufacturers to be used in the arts and industries in cases where denatured alcohol would be unsuitable, and that it shall only be moved or transported under such conditions as the Minister approves.

According to the provisions of the old act alcohol can be denatured for industrial or other purposes only in Ottawa. Methylated spirits for consumption in British Columbia must at present, therefore, be conveyed to that province from Ottawa, a distance of 2,500 miles, at a charge for transportation which, unless borne by the inland revenue department, adds seriously to the price at which the consumer obtains it, while there is at least one distillery in that province which could, under amended regulations, provide all the industrial alcohol required there.

The handicap which the consumers experience in the other provinces is only less serious because the distance of these from Ottawa is less than in the case of British Columbia, but the effect is the same—that is, it tends to limit the use of denatured alcohol, except in a few industrial lines, in which, though the cost counts, it is indispensable for manufacturing purposes.

What the removal of these restrictions on the production of denatured alcohol in Canada would mean may be gathered from the results of this removal on the production in the United States. Before the act of 1906, which permits denaturing of alcohol at any distillery under conditions easily observed, the quantity of denatured alcohol used annually did not exceed 1,500,000 proof wine gallons, but after 1907 the consumption of it increased rapidly, and reached 16,953,355 proof gallons in 1913, and 90,644,722 proof gallons in 1918, while the total amount of denatured alcohol made in Canada in 1917 was only 252,000 proof gallons. If the quantity consumed in Canada were in proportion to population it would amount to 6,000,000 proof Imperial gallons.

Denatured alcohol is all-important in a large number of lines of industry. This may be gathered from the enormously enhanced consumption of it in the United States since 1906, and the annual consumption in Germany of more than 200,000,000 proof Imperial gallons in the year ended Aug. 31, 1904.

### General Chemical Co. Surplus

Report of General Chemical Co. for six months ended June 30 shows surplus, after charges and taxes, of $3,146,472, equivalent, after preferred dividends, to $13.40 a share on $19,822,900 common stock, compared with $1,780,432, or $8.01 on $16,519,200 common stock in 1919, and $3,262,468 or $16.99 a share, on $16,519,200 in 1918.

Inventory as of Dec. 31, 1919, stood at $8,618,485 against $10,614,389 in 1918, and and was the lowest figure since 1916. Demand has been excellent. The company appears to have recovered in some degree from the great cost of production and labor which, together with excess repair charges due to exhaustion through war-time production, ate into 1919 earnings.

During 1919 there was expended on new construction $3,583,567; on repairs charged to expense, $2,348,111, and on repairs charged to reserve for depreciation, $39,715; total of $5,971,393. The extent of the extraordinary repairs can be readily noted when it is seen that since the formation of the company in 1899 to the end of 1918 total repairs charged to expense, together with annual reductions for dismantlements, aggregated $19,007,590.

## Gasoline Shortage in Canada

Advertisements asking everyone to conserve gasoline are being run throughout Canada by oil companies. It is said that in the last few years the demand for crude petroleum, practically all of which comes from the United States, for the manufacture of gasoline in Canada, has increased more than 650 per cent. In the same period production has increased about 150 per cent. A shortage of crude oil and high prices necessarily follow. Pennsylvania crude is today costing $6.10 and Oklahoma crude $3.60 per bbl. at the wells, and these prices must be paid in American funds, which adds another 15 per cent.

The oil-producing companies claim to be sparing no expense or effort to meet the growing demand for petroleum products, but notwithstanding the best efforts of these companies the demand is growing ahead of production by leaps and bounds. The only apparent solution is to use all petroleum products, especially gasoline, economically and efficiently. Those who have studied the subject say that one-half gallon of gasoline per car is wasted daily in Canada through carelessness, the over-use of cars, and needless mileage, which means 200,000 gal. wasted daily in the country, or 73,000,000 gal. per year if all motor cars were operated every day.

## Program of Chicago Meeting, American Ceramic Society

The meeting of the American Ceramic Society, to be held on Aug. 16, 17 and 18, with headquarters at the La Salle Hotel, Chicago, is promised an excellent program by the Chicago Section. This meeting takes the form of a junket in which the members visit the industrial plants and personally witness the manufacturing processes in not only the ceramic industries of this district where methods out of the ordinary are employed in turning out manufactured wares, but also observe processes which are foreign to ceramic manufacture, yet of interest in the unique operations involved. Such arrangement balances well with the usually high technical and educational program which forms the main part of the annual winter sessions.

### Monday, August 16

All members will assemble in the East Room of the Hotel La Salle at 12 o'clock noon (city time—1 hr. faster than Standard Central time) for registration and purchase of trip tickets. These will be sold at nominal cost and cover various incidental expenses such as train fare, taxicabs, luncheons, etc. At 12:30 p.m. the members will proceed to the plant of the Bach Brick Co., at Montrose Ave. and the Chicago River. This plant manufactures common brick, using the automatic setting machine for placing the brick into the kilns, which burn fuel oil.

From the Bach Brick Co., the party will go to the plant of the Northwestern Terra Cotta Co. This is a new and modern plant with a capacity of about 35,000 tons annually, employing processes of manufacture recently installed. The operations at this plant will be a revelation to all the visitors. A 320-ft. Dressler tunnel kiln will be completed for operation at this time. Humidity control drying rooms employing Carrier equipment will also be in operation.

The Chicago Section of the Society through the kindly aid of the patrons will entertain the visitors in the Red Room of the La Salle Hotel at a dinner at 7 o'clock Monday evening. Every member should make it a point to attend this function, at which an unusual after-dinner program will be presented. The details of this program are kept veiled in secrecy.

### Tuesday, August 17

Leaving the La Salle Hotel at 8:30 a.m., visits will be made to the Lindsay Light Co., where the manufacture of gas mantles will be witnessed, and to the factory of the Coomley Manufacturing Co., manufacturer of enamel ware. Lunch will be served at the Western Electric Co., followed by an inspection of the large manufacturing plant, which employs over 14,000 persons and turns out enormous quantities of telephone supplies and other electrical equipment.

### Wednesday, August 18

Members will leave the hotel at 8:30 a.m. for a visit to the plant of the Fansteel Products Co., at North Chicago, where processes of manufacturing pure tungsten and molybdenum will be seen. After luncheon at one of the Waukegan restaurants, the plant of the American Steel & Wire Co. will be visited.

### Visit to Champaign

Members of the faculty of the department of ceramic engineering, University of Illinois, will be glad to escort the visitors prepared to go to Champaign, Ill., a 3-hr. ride from Chicago, through the ceramic building at the University of Illinois on Thursday.

## Natalite as a Motor Fuel

It is reported by the London Automobile Association that natalite, the new motor fuel (so called by reason of its discovery in Natal, South Africa), has been in use in that country for some time past, is well spoken of and has had many favorable reports upon its practicability as a gasoline substitute. It is said to be a byproduct of the Natal sugar industry, and is reported to be a mixture of power alcohol and ether, capable of great development, in view of the large tracts of waste vegetation available in South Africa. A British research committee is now engaged in making regulations respecting the use of this fuel, especially the necessity of denaturing the liquid to prevent its possible use as an intoxicant.

A further statement on the subject mentions the fact that the British Admiralty has been making a series of trials involving the use of natalite on motor boats, the results of which have not yet been made public.

## More Artificial Silk Plants in Italy

Announcement has just been made that the Italian company Societa di Navigazione Italo-Americana, which recently increased its capital and is extending the scope of its activities, will in the near future begin the construction of several new plants for the manufacture of artificial silk. These plants will probably be located at Turin, Naples, Orbasano and Bra. In the first two instances sites have already been purchased, and it is expected that these new plants will give employment to not less than 10,000 workers.

This company, through the controlling interest which it holds both in the "Cines" Seta Artificiale and in the Viscosa Company of Pavia, as well as in the Societa Italiana della Viscosa, which is located at Venaria Reale, near Turin, is already the dominant factor in the artificial silk industry of Italy.

## September Meeting, Dye Division of the American Chemical Society

The next meeting of the Dye Division will be at the fall meeting of the American Chemical Society, to be held in Chicago Sept. 7 to 10, 1920. At that time it is expected that a number of dye concerns will come forward with papers of intensive scientific interest.

There has been considerable feeling in the past that the concerns should keep all their research work secret and that none of it could be revealed at such meetings without detriment. However, since every research laboratory turns out a large amount of work which is of very great scientific interest to the trade in general but may have no specific bearing on any process in particular, it is expected that a large number of papers will be presented of such a nature as to demand the attention of every dye laboratory.

## Citations by Federal Trade Commission

The Federal Trade Commission has cited the following concerns for unfair competition in trade:

Great Western Oil Co., Cleveland, Ohio, for publishing certain untrue advertisements to the effect that a motor fuel manufactured by the company had been indorsed by the Automobile Association of America and recommended by the United States Bureau of Mines.

Quaker Oil Products Corp., Conshohocken, Pa., for having given sums of money and other gratuities to employees of its customers as a means of influencing such employees to induce their employers to purchase respondent's products.

Forty days has been given these companies to reply, after which the cases will be set down for trial on their merits.

## Air Reduction Co. Earnings

The results of the Air Reduction Co.'s operations for the first six months of 1920 have been announced by President A. S. Blagden as follows:

| | | |
|---|---|---|
| Gross income | | $3,410,978.24 |
| Operating expenses | | 2,297,003.13 |
| Operating income | | $1,113,975.11 |
| Reserves for depreciation | $439,272.60 | |
| Accrued bond interest and discount | 38,478.84 | 477,751.44 |
| Net income after current charges | | $636,223.67 |
| Extraordinary charges to profit and loss | | 34,022.49 |
| Net profits earned on outstanding stock, before federal taxes | | $602,201.18 |

Bonds outstanding, $2,000,000 7 per cent convertible sinking fund gold bonds due 1930.

Stock outstanding, 152,992.2 shares of no par value.

Application will be made to list the company's stock on the New York Stock Exchange.

## General Fries and Colonel Atkisson Transferred to C. W. S.

The actual transfer of General A. A. Fries and Colonel Earl J. Atkisson from the Corps of Engineers to the Chemical Warfare Service has just been ordered. These officers were loaned early in the war to the Chemical Warfare Service, but until now have never lost their official status with the Engineers Corps. As a result of their distinguished service in chemical warfare each has attained a rank which would have been improbable had he remained with the Engineers. General Fries, for instance, would have the rank of Major had he stayed with the Engineers, while Colonel Atkisson would have been well down among the Captains.

## Company Reports

### Virginia-Carolina Chemical Co.

Virginia-Carolina Chemical Co.'s annual report for the year ended May 31, 1920, shows surplus, after federal taxes and charges, of $7,352,046, equivalent after preferred dividends to $20.26 a share earned on the 27,984,400 common stock, as compared with $6,665,256, or $18.08 a share, in the preceding year.

### Midvale Steel

All records for production of steel tubes are being broken at new skelp mill of Midvale Steel & Ordnance Co. at Coatesville, Pa., just placed in operation. Experimental runs were made when ten heats a day were run through. Later twenty-two heats were put through. The new furnace has a capacity of 10,000 lb. at each charging.

### Gulf Oil Corporation

Gulf Oil Corporation's output is now about 100,000 bbl. daily. Three-quarters comes from its mid-continent and Gulf coast properties, while its Mexican output makes up the remainder. Mexican shipments by this company in April were 797,662 bbl., or 26,500 daily.

### Hercules Powder Co.

Hercules Powder Co. for six months ended June 30, 1920, reports net earnings, after charges and federal taxes, $1,265,285, against $488,421 for same 1919 period.

## U. G. I. On Heat Unit Basis

By the change from the illuminating to the heat unit standard United Gas Improvement will not only be relieved of the difficulty of getting supplies of oil but will benefit financially to a very substantial extent. The service, it is promised, will not be allowed to suffer, the change being in conformity with modern gas standards and requirements.

It has been officially estimated that it will save at least 50,000,000 gal. of oil a year, a difference which will probably enable the company to earn enough in Philadelphia to cover all betterment expenditures and write them off, or in other words keep up these sinking fund accounts against termination of the lease, and leave some balance of profit for the company itself.

Higher costs of manufacture have not been offset in Philadelphia by an advance in rates, which are fixed under the terms of the lease of the city gas works, though at other points through the country where the company operates fully $2,000,000 more per annum has been realized from rate increase allowed by public service commissions. Coal is costing the public utilities companies high prices but supplies of fuel are being assured them by special measures taken by the federal authorities.

## U. S. Bulletin on Open Shop

The United States *Bulletin* of July 12 contains the following statement: "The idea of making the possession of a union card a condition of employment is an economic absurdity; and as such is unworthy of a moment's consideration. Unions have improved labor conditions in certain labor matters, but are totally unwarranted in demanding that they be given autocratic rights in industrial relations; just as much so as are particular types of employers in ignoring reasonable rights of labor."

### Chemical Industries to Be Represented on Superpower Board

The electrochemical and byproduct industries are to be represented on the advisory board of the superpower survey. The importance of having these industries represented was emphasized by O. P. Hood, who represents the Bureau of Mines in the survey. The selection of the representative of these industries will be made in the near future.

While it is recognized that the railroads are likely to be the largest single consumer of power, the chemical industries will play an important part in the survey now under way. Not only are they large consumers of power but it is believed that they will do a great deal to equalize the load. Since many of the chemical industries can be operated so as to use larger amounts of current at night and in seasons of the year when other consumers are taking minimum amounts of current, a detailed study will be made of that phase of the situation.

One of the principal questions to be determined is the location of the central power plants. If the byproducts of coal distillation are to be recovered at the plant, it cannot be located at the mine mouth.

In order to secure a better load factor it is regarded as probable that a much cheaper rate can be made for the off-peak hours. It is believed that this rate can be made sufficiently attractive to bring a great many chemical industries into the Boston-Washington area. Special attention will be paid to the possibilities of developing nitrogen fixation. Electic smelting, the melting of brass and the refining of metals are activities which will be studied in connection with the survey.

## Book Reviews

THE MINES HANDBOOK. Vol. 14. By *Walter Harvey Weed*. 1992 pp. New York: W. H. Weed. Price $15.

Although this book is compiled with the object of producing a manual of the mining industry of the world, it contains many data of interest to the chemist and metallurgist. For the benefit of readers who are unfamiliar with the earlier volumes the following summary of the scope of the work is given:

The main portion of the volume (chap. 4 *et seq.*) serves as a source of information concerning about 7,000 mining companies interested in the production of ferrous and nonferrous metals throughout the world. As far as possible the following data are given for each company: Office; officers; date and place of incorporation; financial statement; description of property, including geology; equipment; production statistics. In many cases there is added a comment by the editor upon the management and prospects of the company. The sections dealing with equipment should be of interest to metallurgists, particularly in the case of the larger companies having smelting and refining departments or subsidiaries.

The first three chapters contain general information: A glossary of mining terms, a brief description of the principal ore minerals of each metal, and a résumé of the mining industry, giving production statistics, prices, uses, mines, producers and (in a few instances) buyers of the various metals and their ores.

The time-saving feature of a compilation of this character is best appreciated by those who have been forced to search through scattered sources for similar data. Since much of the material in this book can be found in no other source, it is especially valuable for reference.

ALAN G. WIKOFF.

TECHNICAL WRITING. By *T. A. Rickard*. 178 pp. New York: John Wiley & Sons; London: Chapman & Hall, Ltd.

This book, the author announces in his preface, grew from a set of five lectures delivered before the engineering classes of the University of California. Mr. Rickard says truly: "Indeed, the engineer does bungle language deplorably. He makes a fetish of efficiency, yet he shows no regard for the effective use of one of his most important tools—the pen; he believes devoutly in accuracy, yet he employs a weapon of precision as carelessly as a small boy handles a gun." It may be that the engineer considers he has fulfilled his mission if he "gets there"—that is, if he says what he has to say in his own way, no matter how imperfectly, so long as he says it. There is no doubt, however, that he would "get there" with greater effect if he expressed his ideas in concise, clear-cut language, with every word conveying the meaning he intends to convey and no other, with each sentence built up in an orderly manner and with the sentences so arranged as best to deliver his message.

All this and more the author points out, and he gives numerous instances of the pitfalls into which writers for the technical press commonly tumble. His points are well taken, and the literary tone of our technical literature would be improved if every writer would digest and put into practice the principles he lays down. It is a book that our writers for engineering journals would do well to read, read again and then keep conveniently at hand for ready reference when preparing their manuscripts.

CHARLES N. HULBURT.

## Personal

JAMES N. DIPP, a young student of chemistry, has been missing from his home at 525 West 47th St., New York City, since July 24. He is seventeen years of age, 5 ft. 8 in. tall, weighs 120 lb., has blue eyes, smooth face, dark blond hair, light complexion and is of slender build. He wore a blue serge jacket and long pants, gray checked cap, brown silk socks, black high lace shoes (size 8½D—style 350, Coward), lavender striped shirt and collar, four-in-hand Oriental tie, gold signet ring (initials J. N. D.) and black iron ring, both worn on middle fingers, light tortoise-shell gold-rim eyeglasses. Behind his left ear there is a scar 1¼ in. long, caused by a mastoid operation. Please notify A. C. Dipp at the above address or Police Headquarters, Department of Missing Persons, of your city or New York City.

ANDREW M. FAIRLIE, sulphuric acid plant specialist, of Atlanta, Ga., has been retained as consultant in connection with the design and construction of a new 75-ton sulphuric acid plant for the American Zinc, Lead & Smelting Co., to be erected this fall at Columbus, Ohio.

A. M. HEINZELMANN, who has been specializing in inks and varnishes at the Bureau of Standards, has resigned to enter private employment.

Dr. W. F. HILLEBRAND, chief chemist of the Bureau of Standards, is taking a two months' vacation. S. S. Voorhies will act as chief chemist during his absence.

H. LEE, contracting engineer of the Koppers Co., Pittsburgh, Pa., sailed from Liverpool, Aug. 7, after several weeks' inspection of European byproduct coke plants.

C. T. MCCONNELL has become associated with the Central Scientific Co., of Chicago, to undertake the reorganization of the chemical department. Mr. McConnell was graduated at Northwestern University in 1903 and subsequently served upon the chemical staff of Pfister & Vogel Leather Co., Milwaukee; the International Harvester Co. and the Western Electric Co., Chicago.

DAVID J. PRICE, who has been for several years engineer in charge of the grain dust explosion investigations of the

Bureau of Chemistry, has just been designated as chief of the newly created development section of that bureau. In this new work Mr. Price will co-operate with the chiefs of the various research sections of the bureau in the development and application industrially of research conclusions.

WALTER L. REMICK recently resigned as assistant metallurgist of the U. S. Metals Refining Co. and is now test engineer for the Research Corporation.

# Obituary

RUSSELL WELLMAN MOORE, who was chief chemist of the U. S. Customs Service from 1898 to 1910, died on July 31 of heart disease at his home, 44 West 77th Street, New York City, at the age of fifty-eight. He was chemist in the New York State Dairy Department from 1885 to 1888, when he was made examiner under the United States Appraiser at New York. On leaving the Customs Service he became manager of the United States Conditioning & Testing Co., until his appointment to the Municipal Explosives Commission.

# Current Market Reports

## The Iron and Steel Market

*Pittsburgh, August 6, 1920.*

The pig iron and steel markets are extremely dull, but this is quite in keeping with the time of year and accordingly is not regarded as an unfavorable factor. A week ago there was ground for reporting that transportation conditions as affecting the iron and steel industry had rounded the turn. Since then there has been improvement, but the improvement has been barely appreciable. While shipments of steel are slightly heavier than they were a fortnight ago, they do not represent the total of production. Accumulating of steel is now confined almost wholly to semi-finished material and does not represent any large tonnage. Except for the partial clean-up in the Chicago district practically none of the steel accumulated in the past four months has been moved. The total of the accumulation is probably in the neighborhood of 2,500,000 tons.

The Interstate Commerce Commission has made a further modification of the coal car preference order by which flat bottom gondolas are not coal cars unless measuring 38 in. high or more inside. This releases quite a number of cars, chiefly cars measuring 36 in. The general preference order has still a fortnight to run, and there are good chances that the coal mines will be well enough supplied with cars to load all the coal the men will mine, and a continuance of the order for another thirty days may be avoided. The probability is, however, that the preference will be continued in modified form.

That the railroads are functioning much better than two months ago is seen by the fact that steel shipments are at least as large as at that time, while meantime large numbers of cars have been diverted to the coal movement. The iron and steel industry believes that transportation conditions will continue to improve, and improve at a more rapid rate than of late. Car supplies at blast furnaces are visibly improved, and it would appear that on an average the furnaces are shipping as much pig iron currently as they make. There are some stocks still to be moved, but the stocks are not large.

While shipments of pig iron and steel products are fair in point of tonnage, so that the situation is much less burdensome to producers than formerly, a corresponding measure of relief has not been experienced by consumers, for the distribution of the material is very poor on account of various embargoes. For this reason some consumers find themselves well supplied with material while others are getting very little.

### RAILROAD BUYING

The settlement of the rate case by the Interstate Commerce Commission on terms that are generally considered quite advantageous to the railroads naturally creates expectations that the railroads will become fairly large buyers of equipment and other things. Such expectations should be conservative, however, since it seems to be human nature to overestimate the quantitative importance of railroad buying. There have been various disappointments in the past. When, early in February of last year, the discussion of means to stabilize prices began and definite action was taken in the case of pig iron and steel by the Industrial Board prices effective March 21, 1919, the common expectation was that there would be large railroad purchases. It was thought the railroads could not get along without large purchases, and the Railroad Administration was severely criticized for not "accepting" the Industrial Board prices. Almost a year and a half has passed since then, and the experience of the period has been that the greater difficulty of the railroads has been in utilizing efficiently the equipment it did have.

As suggestive of the tonnage significance to the steel industry of possible railroad purchases reference may be made to one concrete program, that involved in the policy adopted a few weeks ago by the Interstate Commerce Commission, to lend the railroads $75,000,000 from the revolving fund, the railroads to do some financing themselves, and the money to be used in buying rolling stock. Upon request of the commission the Association of Railway Executives submitted a program, which involved the purchase of 45,021 freight cars valued at $143,569,730 and 599 freight and 239 switching locomotives valued at $53,737,358, making a total of expenditures of a trifle under $200,000,000. Orders have already been placed representing about 55 per cent of the expenditure. For building the total number of cars and locomotives mentioned a total of about a million net tons of rolled steel products would be required. The steel industry's capacity in finished rolled steel is about 45,000,000 net tons a year, this estimate being based upon taking the mean between estimates of ingot capacity of 50,000,000 and 55,000,000 gross tons, applying the factor shown by statistics of 76 per cent to determine the finished rolled steel, and passing from gross to net tons. Thus the steel involved in the program mentioned would be equivalent in tonnage to the steel industry's entire capacity for about seven working days. Of course there will be other purchases, but they will not be made rapidly. It is plain that the railroad executives are bent, as they should be, upon securing first the maximum of efficiency from existing physical facilities.

### BETTER SENTIMENT

There is an improved tone in the iron and steel markets. The settlement of the freight rate case is expected to exercise an important sentimental influence upon business generally, and, after all, the ups and downs of the iron and steel trade are dependent strictly and directly upon general business. No one consuming industry is an important factor. Thus while early in the year the automobile industry made a great deal of noise in the iron and steel market, and was the chief instrumentality by which steel prices for early deliveries experienced such great advances, the most liberal computations showed that the automobile industry operating full could not engage as much as 7 per cent of the steel-making capacity. The industry has not run full, and if it should drop to 50 per cent the steel industry would not lose demand equal to more than 3 per cent of its capacity, a loss that would be quite inappreciable.

As to the immediate future, an interesting question is whether a general improvement in transportation conditions will make the steel market more active. On the one hand business generally would be stimulated and consumption increased, but on the other hand the allaying of fears of buyers that they might not secure deliveries might cause them to be more conservative in buying.

As to general readjustment in commodity prices, wage rates and labor performance, the iron and steel industry does not see that much progress has been made to date, and has doubts whether building construction on a really large scale will soon be resumed. It has always been held that such permanent construction work is necessary if there is to be a full demand for steel.

PRICES

Steel Corporation prices are of course unchanged, and there is no definite trend in prices of the large independents. Prices for really early deliveries continue to decline, except in sheets. Pig iron shows a slight advancing tendency, recent advances of $1 a ton in the valley market being followed by a 50c. advance in basic, to $46.50 valley. The market in general is hardly on a stable foundation when pig iron shows an advancing tendency and steel a declining tendency, even though in each case the tendency is but a slight one.

## The Chemical and Allied Industrial Markets

*New York, August 6, 1920.*

There being no changes in the market during the week the following table has been prepared to show by comparison the position of the *sodium salts* today and a year ago. It will be noticed that there is but a single exception to the general increase of from 20 to 200 per cent in price and that occurs in *sodium silicate*, which was being offered at the same price a year ago. Although the comparison is not very general, it can be seen that last week's prices correspond almost exactly with current offerings, which points to the fact that despite the slow season these prices are firmly fixed at the present levels.

SODIUM SALTS

| | Today | Last Week | Last Year |
|---|---|---|---|
| Soda ash | $3.20 @ $3.65 | $3.20 @ $3.65 | $1.85 @ $2.50 |
| Sodium acetate | .10 @ .25 | .10 @ .25 | .06 @ .07 |
| Sodium bicarbonate | 2.50 @ 3.00 | 2.50 @ 3.50 | 2.35 @ 3.00 |
| Sodium bichromate | .22 @ .27 | .22 @ .27 | .11 @ .13 |
| Sodium bisulphate | 7.00 @ 11.00 | 7.00 @ 11.00 | 3.00 @ 8.00 |
| Sodium bisulphite | .08½@ .11 | .08 @ .09 | .01½@ .02½ |
| Sodium borate | .09 @ .12 | .09 @ .12 | .07½@ .08 |
| Sodium carbonate | 1.50 @ 2.00 | 1.50 @ 2.00 | 1.35 @ 1.75 |
| Sodium chlorate | .11 @ .14 | .11 @ .13 | .15 @ .18½ |
| Sodium cyanide | .25 @ .35 | .25 @ .35 | .30 @ .34 |
| Sodium fluoride | .18 @ .20 | .17 @ .20 | .13 @ .15 |
| Sodium hydroxide | 6.25 @ 7.00 | 6.25 @ 7.00 | 2.75 @ 3.50 |
| Sodium nitrate | 3.00 @ 4.00 | 3.00 @ 4.00 | 2.50 @ 3.25 |
| Sodium nitrite | .16 @ .20 | .15 @ .20 | .09½@ .13 |
| Sodium prussiate | .23 @ .30 | .23 @ .30 | .18 @ .20 |
| Sodium silicate | .01½@ .02½ | .01½@ .02½ | .01½@ .02½ |
| Sodium sulphate | 1.60 @ 2.50 | 1.60 @ 2.50 | 1.05 @ 2.00 |
| Sodium sulphite | .04 @ .05 | .04 @ .05 | .03½@ .04 |
| Sodium sulphide | .09½@ .11 | .09½@ .11 | .05 @ .06 |

COAL-TAR PRODUCTS

The coal-tar products market seems to have finally reached a firm footing as regards prices and the skyrocketing of a few months back has completely subsided. In keeping with the complaints of producers of the increased cost of production of the coal-tar products, manufacturers of *xylol* have advanced this item in all grades, prices being: *pure*, drums, 47½@50½c. per gal.; tanks, 45c.; *commercial*, drums, 32½@35½c.; tanks, 30c. per gal. The remainder of the list has held firm and sales have been confined within last week's ranges. *Naphthalene* continues scarce and although there are some small lots available around 20c. there are no large sized quantities being offered.

The following is a comparison of coal-tar base products prices of today and one year ago:

| | Today | Last Year |
|---|---|---|
| Benzol | .35 @ .40½ | .24 @ .28 |
| Toluol | .35 @ .38 | .22 @ .24 |
| Xylol | .47 @ .50½ | .37 @ .45 |
| Solvent naphtha | .33½@ .35½ | .20 @ .27 |
| Cresol | .18 @ .19 | .18 |
| Salol | .90 @ $1.00 | .75 @ .80 |

NAVAL STORES

*Rosin* prices remain unchanged despite the increased volume of business in the South during the week. The Southern market has been very strong, with South American and European buying interests taking an active part, and as a result the market has a decidedly firmer tone than has been noticed for some time back. However, the local market is straggling along on insufficient supplies due to the inability of producers to make deliveries from Savannah, and prices are merely nominal for the little material available. *Turpentine*, after a slight drop earlier in the week, came up toward the end and is now being held at $1.70 per gal.

CRUDE RUBBER

The condition of the crude rubber market is very serious. Practically no business has been transacted in months and several firms are carrying material on their books representing 20@25c. per lb. drops. One large firm is reported to be tottering financially and unless a decided turn for the better comes soon this company and others that have connections with it will be in a bad way. Buyers have shown no interest even in prevailing low prices and with complete shutting down of a large automobile manufacturer and the curtailment of output of all tire manufacturers it will be some time before the market returns to normal condition.

FLUORSPAR

Until shortly after the war started Illinois and Kentucky had been the principal producing centers of fluorspar, but the demand that suddenly sprang up was of such proportions that new resources were necessary to meet requirements. It was at this time that the New Mexico, Colorado and Utah fields were discovered and opened up with an output far below Illinois or Kentucky. According to the United States Geological Survey the total production of New Mexico, Colorado and Utah amounted to 12,600 tons, while Illinois produced 86,200 and Kentucky 22,400 tons, a total output of 122,000 tons. The average price in 1917 per ton was $10.45; in 1918 that had almost doubled, to $20.72, an exact increase of 98 per cent, while current quotations indicate a still further rise and shortage of materials.

## The Chicago Market

*Chicago, Ill., August 4, 1920.*

Real interest seems lacking in all lines and, with the exception of naval stores, practically all items remain either unchanged in price or lower. Transportation troubles have eased up, being confined now almost entirely to difficulty in securing cars. Once a car is received and loaded by a shipper it proceeds to its destination with but little delay. Spot stocks continue low and as most sources of supply are booked up full under contracts, there is not much chance of their being replenished to any great extent in the near future. This fact occasions no concern to buyers, who are content with purchasing supplies on what is practically a hand-to-mouth basis. The market remains wholly without spectacular features.

HEAVY CHEMICALS

*Alkali* products are in but little better supply than when last reported. Fractional fluctuations downward were recorded last week, but such weakness was only temporary. *Soda ash* is practically unobtainable in barrels. Current quotation in bags is 3¼@3½c. per lb. in carload quantities. Transactions are few. *Caustic* soda retains the high price level of two weeks ago, 6c. being paid for the solid and 6½c. for the gran. *Sal soda* remains unchanged at $1.80@$1.90 per cwt. and *bleaching powder*, still scarce almost to the famine point, is quoted up to 7c. per lb.

*Alcohol* has shown no change in over a month. The supply on hand is gradually increasing, but is still far below the demand. Current quotations are: *Ethyl* grade, $5.57½ per gal., in single barrels, 5c. less in 5-bbl. lots. *Methyl*, very scarce, is priced at $3.65 per gal. for 95 per cent and *denatured*, in somewhat better supply than other grades, is held at $1.09 per gal. *Formaldehyde* is firm and unchanged at 55c., which does not seem high when compared with the price of *methyl* alcohol. Buyers, however, evidently anticipate better prices, as demand is not at all heavy.

Supply of *glycerine* is sufficient to fill all orders. In spite of expected advances the price is steady at 29c. per lb. for c.p. and buyers show no eagerness for offerings. *Arsenic*

(white) has weakened on a quiet market, price falling off from the former level of 17c. to 15c. per lb. Supply is limited and this low price is not likely to prevail for long. The powdered *sulphide* (red), with ample supply, is steady at 20c. *Barium chloride*, influenced by fresh importations, is now quoted at $165 a ton. Prices on all other barium products remain firm. *Glauber's salts* is still scarce in the spot market, price ruling around $3 per cwt. *Liquid chlorine*, firm at 9c. per lb., is in steady demand and fair supply.

### Slight Drop in Prices of Acids

Supply and demand of various *acids* are now so evenly matched as to occasion a slight drop in prices asked on some items. *Acetic* is offered in sufficient quantity to fill all wants, at current quotation of $3.75 per cwt., against $3.87½ two weeks ago. *Boric* is in better supply than for some time and is quoted at 14½c. per lb. Domestic *carbolic*, at 12c., the Government price, is in light demand. *Hydrofluoric*, 30 per cent, is quoted at 9c., containers extra, and is almost impossible to get in any quantity. *Muriatic* is in a little better supply than when last reported and is now offered at from $3@$3.15 per cwt. for 22 degree. *Nitric* is in weak demand and unchanged at 8c. per lb. for 42 degree. *Sulphuric*, 66 degree, is now offered at $22 a ton, with most of the business being done by the makers.

### Vegetable Oils

As is usual on a falling market business is negligible in *linseed oil*, a quotation being made of $1.50 per gal. in tank cars but no interest being shown by buyers. Fall futures are being offered in Minneapolis at 40c. under this figure and naturally no one will pay the spot price if he can get along without the oil. All other oils are very quiet, there being practically no demand. Prices are either unchanged or fractionally lower, and no improvement in conditions is anticipated until such time as consumers re-enter the market and again establish a normal demand.

### Naval Stores

The expected slump in the price of *turpentine* failed to materialize. On increased receipts prices dropped last week to $1.72 per gal., but buyers entering the market immediately sent it back up to $1.74½ and then to $1.76½, where it now stands. As the crop expectation for this year is only about 60 per cent of former average it does not seem probable that any considerable drop will occur. Supplies are coming through from the South now with greater freedom than for some time, one car having made the trip from Georgia to Chicago in six days. The worst shippers' trouble is in securing cars. There is no let-up in the demand for *pine oil* and all prices in the line remain unchanged.

## The St. Louis Market

*St. Louis, Mo., August 3, 1920.*

The St. Louis chemical market continues quiet and prices are unchanged. The supply of chemicals is ample to meet present demands. The recent strike of miners in the southern Illinois coal district threatened to close down manufacturing plants in this district, but latest reports indicate that the miners are returning to work and coal shortage will soon be relieved.

The demand for *sulphuric acid* continues good and prices are unchanged, quoted in carload lots at $16 per ton for 60 degree; $24 per ton for 66 degree, and $27.50 per ton for *oleum*. *Muriatic acid* is unchanged at $25 per ton in carload lots and 2c.@2¼c. per lb. in carboys for the 18 degree grade. The supply of *sodium bisulphate* is now ample and the quotation is $6 per ton in carload lots.

*Nitric acid* is quoted at $7 per hundred pounds for 36 degree and $10 per hundred pounds for 42 degree. Standard mixed acid, consisting of 36 degree nitric and 61 degree sulphuric, is quoted at 11½c. per lb. of nitric and 1½c. per lb. of sulphuric, in carload lots.

*Zinc chloride*, 50 per cent solution, is priced at $3.50@$3.75 per hundred pounds, in carload lots. The supply of *phenol* is plentiful. The price is unchanged at 12c. per lb., in carload lots.

## General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

| | | Carlots | Less Carlots |
|---|---|---|---|
| Acetic anhydride | lb. | ..... | $0.65 – $0.75 |
| Acetone | lb. | $0.15 – $0.20 | .21 – .22 |
| Acid, acetic, 28 per cent | cwt. | 3.50 – 3.75 | 4.00 – 4.50 |
| Acetic, 56 per cent | cwt. | 6.50 – 7.50 | 8.50 – 9.50 |
| Acetic, glacial, 99½ per cent, carboy | cwt. | 14.00 – 16.00 | 16.25 – ..... |
| Boric, crystals | lb. | .15½ – .16 | .16½ – .19 |
| Boric, powder | lb. | .15½ – .16½ | .17 – .20 |
| Citric | lb. | .78 – .80 | .82 – .84 |
| Hydrochloric (nominal) | cwt. | 2.00 – 3.00 | 3.10 – 4.00 |
| Hydrofluoric, 52 per cent | lb. | .13½ – .14 | .14½ – .15½ |
| Lactic, 44 per cent tech | lb. | .11 – .11½ | .12 – .16 |
| Lactic, 22 per cent tech | lb. | .04½ – .05½ | .06 – .07 |
| Molybdic, C. P | lb. | 4.00 – 4.50 | 4.50 – 5.00 |
| Muriatic, 20 deg. (see hydrochloric) | | ..... | ..... |
| Nitric, 40 deg | lb. | .06 – .07 | .07½ – .08½ |
| Nitric, 42 deg | lb. | .07½ – .08 | .08½ – .09½ |
| Oxalic, crystals | lb. | .55 – .57 | .60 – .65 |
| Phosphoric, Ortho, 50 per cent solution | lb. | .14 – .23 | .24 – .25 |
| Pieric | lb. | .28 – .35 | .40 – .50 |
| Pyrogallic, resublimed | lb. | 2.30 – 2.55 | 2.60 – 2.65 |
| Sulphuric, 60 deg., tank cars | ton | 14.00 – 16.00 | ..... |
| Sulphuric, 60 deg., drums | ton | ..... | ..... |
| Sulphuric, 66 deg., tank cars | ton | 16.00 – 17.00 | 18.00 – 20.00 |
| Sulphuric, 66 deg., drums | ton | 26.00 – 28.00 | ..... |
| Sulphuric, 66 deg., carboys | ton | ..... | ..... |
| Sulphuric, fuming, 20 per cent (oleum) tank cars | ton | 27.00 – 30.00 | 37.00 – 42.00 |
| Sulphuric, fuming, 20 per cent (oleum) drums | ton | 28.00 – 30.00 | 38.00 – 42.00 |
| Sulphuric, fuming, 20 per cent (oleum) carboys | ton | 32.00 – 35.00 | 40.00 – ..... |
| Tannic, U. S. P | lb. | 1.45 – 1.50 | 1.55 – 1.65 |
| Tannic (tech.) | lb. | .60 – .70 | .80 – .90 |
| Tartaric, crystals | lb. | ..... | .74 – .77 |
| Tungstic, per lb. of WO | lb. | ..... | 1.20 – 1.40 |
| Alcohol, Ethyl (nominal) | gal. | 5.10 – 5.50 | 6.00 – 7.00 |
| Alcohol, Methyl, 95% | gal. | ..... | 3.25 – 3.30 |
| Alcohol, Methyl, pure | gal. | ..... | 3.50 – 3.55 |
| Alcohol, denatured, 188 proof (nominal) | gal. | ..... | 1.10 – 1.15 |
| Alcohol, denatured, 190 proof (nominal) | gal. | ..... | 1.05 – 1.10 |
| Alum, ammonia lump | lb. | .05 – .05½ | .05½ – .06 |
| Alum, potash lump | lb. | .08 – .08½ | .09 – .09½ |
| Alum, chrome lump | lb. | .15½ – .18 | .19 – .20 |
| Aluminum sulphate, commercial | lb. | .04½ – ..... | ..... |
| Aluminum sulphate, iron free | lb. | .06 – ..... | ..... |
| Aqua ammonia, 26 deg., drums (750 lb.) | lb. | .09½ – .10½ | .11 – .12 |
| Ammonia, anhydrous, cylinders (100-150 lb.) | lb. | .34 – .35 | .35 – .40 |
| Ammonium carbonate, powder | lb. | .16 – .16½ | .17 – .18 |
| Ammonium chloride, granular (white salammoniac) (nominal) | lb. | .16 – .16½ | .17 – .18 |
| Ammonium chloride, granular (gray salammoniac) | lb. | .13 – .13½ | .13½ – .14½ |
| Ammonium nitrate | lb. | .09 – .10 | .11 – .14 |
| Ammonium sulphate | lb. | .07 – .07½ | .08½ – ..... |
| Amylacetate | gal. | ..... | 5.00 – ..... |
| Amylacetate tech | gal. | ..... | 4.75 – 5.25 |
| Arsenic, oxide, lumps (white arsenic) | lb. | .15½ – .16 | .16½ – .17 |
| Arsenic, sulphide, powdered (red arsenic) | lb. | .20 – .21 | .22 – .25 |
| Barium chloride | ton | 150.00–160.00 | ..... |
| Barium dioxide (peroxide) | lb. | .21 – .23 | .24 – .25 |
| Barium nitrate | lb. | .10 – .12 | .12½ – .13½ |
| Barium sulphate (precip.) (blanc fixe) | lb. | .04½ – .05 | .05½ – .06 |
| Bleaching powder (see calcium hypochlorite) | | ..... | ..... |
| Blue vitriol (see copper sulphate) | | ..... | ..... |
| Borax (see sodium borate) | | ..... | ..... |
| Brimstone (see sulphur, roll) | | ..... | ..... |
| Bromine | lb. | .70 – .90 | 1.00 – 1.05 |
| Calcium acetate | cwt. | 3.50 – 3.55 | ..... |
| Calcium carbide | lb. | .04½ – .04¾ | .04¾ – .05½ |
| Calcium chloride, fused, lump | ton | 25.00 – 30.00 | 35.00 – 45.00 |
| Calcium chloride, granulated | lb. | .01½ – .01¾ | .02 – .03½ |
| Calcium hypochlorite (bleaching powder) | cwt. | ..... | 4.50 – 6.50 |
| Calcium peroxide | lb. | ..... | 1.50 – 1.70 |
| Calcium phosphate, monobasic | lb. | ..... | .75 – .80 |
| Calcium sulphate, pure | lb. | ..... | .25 – .30 |
| Carbon bisulphide | lb. | .08 – .09 | .10 – .11 |
| Carbon tetrachloride, drums | lb. | .14 – .15 | .16 – .17 |
| Carbonyl chloride (phosgene) | lb. | ..... | .80 – 1.05 |
| Caustic potash (see potassium hydroxide) | | ..... | ..... |
| Caustic soda (see sodium hydroxide) | | ..... | ..... |
| Chlorine, gas, liquid-cylinders (100 lb.) | lb. | .09 – .09½ | .10 – .10½ |
| Chloroform | lb. | .40 – .43 | .44 – .47 |
| Cobalt oxide | lb. | ..... | 2.00 – 2.05 |
| Copperas (see iron sulphate) | | ..... | ..... |
| Copper carbonate, green precipitate | lb. | .27 – .28 | .29 – .31 |
| Copper cyanide | lb. | ..... | .65 – .70 |
| Copper sulphate, crystals | lb. | .08 – .09 | .09 – .09½ |
| Cream of tartar (see potassium bitartrate) | | ..... | ..... |
| Epsom salt (see magnesium sulphate) | | ..... | ..... |
| Ethyl Acetate Com. 85% | gal. | 1.10 – 1.30 | 1.40 – ..... |
| Ethy Acetate pure (acetic ether 98% to 100%) | | ..... | 1.75 – ..... |
| Formaldehyde, 40 per cent (nominal) | lb. | .40 – .50 | .52 – .55 |
| Fusel oil, ref | gal. | ..... | 5.25 – 6.00 |
| Fusel oil, crude (nominal) | gal. | ..... | ..... |
| Glauber's salt (see sodium sulphate) | | ..... | ..... |
| Glycerine, C. P. drums extra | lb. | ..... | .26½ – .28½ |
| Iodine, resublimed | lb. | 4.30 – 4.35 | 4.40 – 4.45 |
| Iron oxide, red | lb. | ..... | .03 – .20 |
| Iron sulphate (copperas) | cwt. | ..... | 2.20 – 2.50 |
| Lead acetate, normal | lb. | ..... | .13½ – .16 |
| Lead arsenate (paste) | lb. | .11 – .12 | .13 – .17 |
| Lead nitrate, crystals | lb. | ..... | .90 – 1.00 |
| Litharge | lb. | .14 – .15 | .15½ – .16 |
| Lithium carbonate | lb. | ..... | 1.50 – ..... |
| Magnesium carbonate, technical | lb. | .12½ – .13½ | .15 – .16 |
| Magnesium sulphate, U. S. P | 100 lb. | 3.50 – 3.90 | 4.00 – 4.50 |
| Magnesium sulphate, commercial | 100 lb. | ..... | 3.50 – 3.60 |
| Nickel salt, double | lb. | ..... | .14 – .16 |
| Nickel salt, single | lb. | ..... | .13 – .14 |
| Phosgene (see carbonyl chloride) | | ..... | ..... |
| Phosphorus, red | lb. | .50 – .55 | .60 – .65 |
| Phosphorus, yellow | lb. | ..... | .35 – .37 |
| Potassium bichromate | lb. | .50 – .55 | .57 – .60 |

| | | Carlots | Less Carlots |
|---|---|---|---|
| Potassium bitartrate (cream of Tartar) | lb. | $0.52 – $0.56 | $0.57 – $0.58 |
| Potassium bromide, granular | lb. | – | .70 – .73 |
| Potassium carbonate, U. S. P. | lb. | .50 – .55 | .56 – .60 |
| Potassium carbonate, crude | lb. | .20 – .25 | .26 – .28 |
| Potassium chlorate, crystals | lb. | .16 – .17½ | .18 – .20 |
| Potassium hydroxide (caustic potash) | lb. | .30 – .33 | .35 – .38 |
| Potassium iodide | lb. | – | 3.35 – 3.60 |
| Potassium nitrate | lb. | .17 – .17½ | .19 – .21 |
| Potassium permanganate | lb. | .75 – .80 | .85 – .95 |
| Potassium prussiate, red | lb. | .90 – 1.00 | 1.05 – ..... |
| Potassium prussiate, yellow | lb. | .32 – .36 | .35 – .40 |
| Potassium sulphate (powdered) | ton | $225.00 – 240.00 | ..... – ..... |
| Rochelle salts (see sodium potas. tartrate) | ..... | – | ..... – ..... |
| Salammoniac (see ammonium chloride) | ..... | – | ..... – ..... |
| Sal soda (see sodium carbonate) | ..... | – | ..... – ..... |
| Salt cake | ton | – | 40.00 – 50.00 |
| Silver cyanide (nominal) | oz. | – | 1.25 – ..... |
| Silver nitrate (nominal) | oz. | – | .60 – .62 |
| Soda ash, light | 100 lb. | – | 3.20 – 3.50 |
| Soda ash, dense | 100 lb. | – | 3.55 – 3.65 |
| Sodium acetate | lb. | .10 – .15 | .20 – .25 |
| Sodium bicarbonate | 100 lb. | 2.50 – 2.75 | 3.00 – 3.50 |
| Sodium bichromate | lb. | .22 – .24 | .25 – .27 |
| Sodium bisulphate (nitre cake) | ton | 7.00 – 8.00 | 9.00 – 11.00 |
| Sodium bisulphite Powered, U.S.P. | lb. | .08½ – | .10 – .11 |
| Sodium borate (borax) | lb. | .09 – .10 | .11 – .12 |
| Sodium carbonate (sal soda) | 100 lb. | 1.50 – 1.80 | 1.80 – 2.00 |
| Sodium chlorate | lb. | .11 – .12 | .12½ – .14 |
| Sodium cyanide, 96-98 per cent | lb. | .25 – .30 | .32 – .35 |
| Sodium fluoride | lb. | .18 – ..... | .19 – .20 |
| Sodium hydroxide (caustic soda) | 100 lb. | – | 6.25 – 7.00 |
| Sodium hyposulphite | lb. | – | .03 – .04 |
| Sodium molybdate | lb. | 2.50 – ..... | 3.25½ – ..... |
| Sodium nitrate | 100 lb. | 3.00 – 3.25 | 3.75 – 4.00 |
| Sodium nitrite | lb. | .16 – .18 | .19 – .20 |
| Sodium peroxide, powdered | lb. | .32 – .35 | .35 – .40 |
| Sodium phosphate, dibasic | lb. | .03½ – .04½ | .04½ – .05 |
| Sodium potassium tartrate (Rochelle salts) | lb. | – | .39 – .40 |
| Sodium prussiate, yellow | lb. | .23 – .27 | .31 – .32 |
| Sodium silicate, solution (40 deg.) | lb. | .01½ – .01¾ | .02 – .02½ |
| Sodium silicate, solution (60 deg.) | lb. | .02¼ – .03 | .04 – .05 |
| Sodium sulphate, crystals (Glauber's salt) | cwt. | 1.60 – 1.70 | 1.75 – 2.50 |
| Sodiumsulphide, crystal, 60–62 per cent (conc) | lb. | .09½ – .10 | .10½ – .11 |
| Sodium sulphite, crystals | lb. | .04 – 0.4½ | .04½ – .05 |
| Strontium nitrate, powdered | lb. | .15 – .18½ | .19 – .20 |
| Sulphur chloride red | lb. | .08 – .09 | .10 – .10½ |
| Sulphur, crude | ton | 16.00 – 20.00 | ..... – ..... |
| Sulphur dioxide, liquid, cylinders | lb. | .09 – ..... | .10 – .12 |
| Sulphur (sublimed), flour | 100 lb. | – | 3.80 – 4.35 |
| Sulphur, roll (brimstone) | 100 lb. | – | 3.40 – 3.90 |
| Tin bichloride (stannous) | lb. | .42½ – .44 | .45 – .46 |
| Tin oxide | lb. | – | .55 – .65 |
| Zinc carbonate, precipitate | lb. | .16 – .18 | .19 – .20 |
| Zinc chloride, gran. | lb. | .13 – .13½ | .13½ – .17 |
| Zinc cyanide | lb. | .45 – .49 | .50 – .60 |
| Zinc dust | lb. | .11 – .12 | .12 – .13 |
| Zinc oxide, U. S. P. | lb. | .17 – .25 | ..... – ..... |
| Zinc sulphate | lb. | .03½ – .03¾ | .04 – .06 |

## Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

| | | | |
|---|---|---|---|
| Alpha naphthol, crude | lb. | $1.40 — | $1.50 |
| Alpha naphthol, refined | lb. | 1.60 — | 1.70 |
| Alpha naphthylamine | lb. | .50 — | .55 |
| Aniline oil, drums extra | lb. | .33 — | .34 |
| Aniline salts | lb. | .40 — | .42 |
| Anthracine, 80% in drums (100 lb.) | lb. | .90 — | 1.00 |
| Benzaldehyde (f.f.c.) | lb. | 2.00 — | 2.10 |
| Benzidine, base | lb. | 1.35 — | 1.40 |
| Benzidine, sulphate | lb. | 1.15 — | 1.25 |
| Benzoic acid, U.S.P. | lb. | .90 — | 1.00 |
| Benzoate of soda, U.S.P. | lb. | .80 — | .90 |
| Benzol, pure, water-white, in drums (100 lb.) | gal. | .35 — | .40½ |
| Benzol, 90%, in drums (100 lb.) | gal. | .33 — | .38½ |
| Benzyl chloride, 95-97%, refined | lb. | .35 — | .40 |
| Benzyl chloride, tech | lb. | .25 — | .35 |
| Beta naphthol benzoate (nominal) | lb. | 3.50 — | 4.00 |
| Beta naphthol, sublimed (nominal) | lb. | ..... — | ..... |
| Beta naphthol, tech (nominal) | lb. | .85 — | .95 |
| Beta naphthylamine, sublimed | lb. | 2.25 — | 2.40 |
| Cresol, U. S. P., in drums (100 lb.) | lb. | .18 — | .19 |
| Ortho-cresol, in drums (100 lb.) | lb. | .23 — | .25 |
| Cresylic acid, 97-99%, straw color, in drums | gal. | 1.05 — | 1.15 |
| Cresylic acid, 95-97%, dark, in drums | gal. | 1.00 — | 1.05 |
| Cresylic acid, 50%, first quality, drums | gal. | .65 — | .75 |
| Dichlorbenzol | lb. | .08 — | .10 |
| Diethylaniline | lb. | 1.50 — | 1.60 |
| Dimethylaniline | lb. | 1.35 — | 1.45 |
| Dinitrobenzol | lb. | .30 — | .37 |
| Dinitroclorbenzol | lb. | .32 — | .35 |
| Dinitronaphthaline | lb. | .45 — | .55 |
| Dinitrophenol | lb. | .40 — | .45 |
| Dinitrotoluol | lb. | .35 — | .40 |
| Dip oil, 25%, tar acids, car lots, in drums | gal. | .38 — | .40 |
| Diphenylamine (nominal) | lb. | .80 — | .85 |
| H-acid (nominal) | lb. | 2.00 — | 2.25 |
| Metaphenylenediamine | lb. | 1.25 — | 1.30 |
| Monochlorbenzol | lb. | .18 — | .20 |
| Monoethylaniline | lb. | 2.00 — | 2.40 |
| Naphthaline crushed, in bbls. (250 lb.) | lb. | .... — | .... |
| Naphthaline, flake | lb. | .... — | .19 |
| Naphthaline, balls | lb. | .... — | .19 |
| Naphthionic acid, crude | lb. | .75 — | .85 |
| Nitrobenzol | lb. | .14 — | .19 |
| Nitro-naphthaline | lb. | .40 — | .50 |
| Nitro-toluol | lb. | .18 — | .25 |
| Ortho-amidophenol | lb. | 3.25 — | 4.25 |
| Ortho-dichlor-benzol | lb. | .15 — | .20 |
| Ortho-nitro-phenol | lb. | .80 — | 1.25 |
| Ortho-nitro-toluol | lb. | .25 — | .40 |
| Ortho-toluidine | lb. | .35 — | .40 |
| Para-amidophenol, base | lb. | 2.50 — | 3.00 |
| Para-amidophenol, HCl | lb. | 2.50 — | 3.00 |
| Para-dichlor-benzol | lb. | .08 — | .12 |
| Paranitraniline | lb. | 1.35 — | 1.40 |
| Para-nitro-toluol | lb. | 1.35 — | 1.50 |
| Paraphenylenediamine | lb. | 2.50 — | 2.65 |
| Paratoluidine | lb. | 2.00 — | 2.25 |
| Phthalic anhydride | lb. | .60 — | .70 |
| Phenol, U. S. P., drums (dest.), (240 lb.) | lb. | .12 — | .20 |
| Pyridin | gal. | 2.00 — | 3.50 |
| Resorcin, technical | lb. | 4.25 — | 4.50 |
| Resorcin, pure | lb. | 6.25 — | 6.75 |
| Salicylic acid, tech., in bbls. (110 lb.) | lb. | .50 — | .52 |
| Salicylic acid, U. S. P. | lb. | .50 — | .60 |
| Salol | lb. | .90 — | 1.00 |
| Solvent naphtha, water-white, in drums, 100 gal. | gal. | .33½ — | .35½ |
| Solvent naphtha, crude, heavy, in drums, 100 gal. | gal. | .23 — | .26 |
| Sulphanilic acid, crude | lb. | .32 — | .35 |
| Toluidine | lb. | 1.70 — | 2.50 |
| Toluidine, mixed | lb. | .45 — | .55 |
| Toluol, in tank cars | gal. | .35 — | ..... |
| Toluol, in drums | gal. | .38½ — | .40½ |
| Xylidine, drums, 100 gal. | lb. | .50 — | .65 |
| Xylol, pure, in drums | gal. | .47½ — | .50½ |
| Xylol, pure, in tank cars | gal. | .45 — | ..... |
| Xylol, commercial, in drums, 100 gal. | gal. | .32½ — | .35½ |
| Xylol, commercial, in tank cars | gal. | .30 — | ..... |

## Waxes

Prices based on original packages in large quantities.

| | | | |
|---|---|---|---|
| Beeswax, refined, dark | lb. | $0.36 — | $0.39 |
| Beeswax, refined, light | lb. | .39 — | .40 |
| Beeswax, white pure | lb. | .63 — | .68 |
| Carnauba, No. 1. (nominal) | lb. | 1.00 — | 1.05 |
| Carnauba, No. 2, regular (nominal) | lb. | .85 — | .88 |
| Carnauba, No. 3, North Country | lb. | .35 — | .36 |
| Japan | lb. | .19 — | .19½ |
| Montan, crude | lb. | .23 — | .25 |
| Paraffine waxes, crude match wax (white) 105-110 m.p. | lb. | .09 — | .09½ |
| Paraffine waxes, crude, scale 124-126 m.p. | lb. | .09½ — | .10 |
| Paraffine waxes, refined, 118-120 m.p. | lb. | .11½ — | .12 |
| Paraffine waxes, refined, 125 m.p. | lb. | .12½ — | ..... |
| Paraffine waxes, refined, 128-130 m.p. | lb. | .14½ — | .15½ |
| Paraffine waxes, refined, 133-135 m.p. | lb. | .16½ — | .17 |
| Paraffine waxes, refined, 135-137 m.p. | lb. | .17½ — | .18½ |
| Stearic acid, single pressed | lb. | .24 — | .25 |
| Stearic acid, double pressed | lb. | .25 — | .26 |
| Stearic acid, triple pressed | lb. | .27 — | .28 |

NOTE—Paraffine waxes very scarce.

## Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

| | | |
|---|---|---|
| Pine oil, steam dist., sp. gr., 0.930-0.940 | gal. | $2.30 |
| Pine oil, pure, dest. dist. | gal. | 1.80 |
| Pine tar oil, ref., sp. gr. 1.025-1.035 | gal. | .48 |
| Pine tar oil, crude, sp. gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla. | gal. | .35 |
| Pine tar oil, double ref., sp. gr. 0.965-0.990 | gal. | .85 |
| Pine tar, ref., thin, sp. gr., 1.080-1.960 | gal. | .36 |
| Turpentine, crude, sp. gr., 0.900-0.970 | gal. | 2.00 |
| Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990 | gal. | .35 |
| Pinewood creosote, ref | gal. | .52 |

## Naval Stores

The following prices are f.o.b., New York, for carload lots.

| | | | |
|---|---|---|---|
| Rosin B-D, bbl. | 280 lb. | $12.25 — | $16.25 |
| Rosin E-I | 280 lb. | 16.60 — | 16.75 |
| Rosin K-N | 280 lb. | 17.00 — | 17.20 |
| Rosin W. G.-W. W | 280 lb. | 17.25 — | 17.50 |
| Wood rosin, bbl. | 280 lb. | 15.00 — | ..... |
| Spirits of turpentine | gal. | 1.70 — | ..... |
| Wood turpentine, steam dist. | gal. | ..... — | ..... |
| Wood turpentine, dest. dist. | gal. | ..... — | ..... |
| Pine tar pitch, bbl. | 200 lb. | ..... — | 8.50 |
| Tar, kiln burned, bbl. (500 lb.) | bbl. | 14.50 — | 15.00 |
| Retort tar, bbl. | 500 lb. | 15.00 — | 15.50 |
| Rosin oil, first run | gal. | .70 — | ..... |
| Rosin oil, second run | gal. | .73 — | ..... |
| Rosin oil, third run | gal. | .92 — | ..... |

## Solvents

| | | |
|---|---|---|
| 73-76 deg., steel bbls. (85 lb.) | gal. | $0.40 |
| 70-72 deg., steel bbls. (85 lb.) | gal. | .38 |
| 68-70 deg., steel bbls. (85 lb.) | gal. | .37 |
| V. M. and P. naphtha, steel bbls. (85 lb.) | gal. | .29 |

## Crude Rubber

| | | | |
|---|---|---|---|
| Para—Upriver fine | lb. | $0.33 — | $0.34 |
| Upriver coarse | lb. | .21½ — | .22 |
| Upriver caucho ball | lb. | .21 — | .21½ |
| Plantation—First latex crepe | lb. | .30 — | ..... |
| Ribbed smoked sheets | lb. | .29½ — | ..... |
| Brown crepe, thin, clean | lb. | .27 — | ..... |
| Amber crepe No. 1 | lb. | .29 — | ..... |

## Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

| | | | |
|---|---|---|---|
| Castor oil, No. 3, in bbls. | lb. | $0.17 — | $0.18 |
| Castor oil, AA, in bbls. | lb. | .19 — | ..... |
| China wood oil, in bbls. | lb. | .18½ — | .19 |
| Cocoanut oil, Ceylon grade, in bbls. | lb. | .16 — | ..... |
| Cocoanut oil, Cochin grade, in bbls (nominal) | lb. | .17½ — | .17½ |
| Corn oil, crude, in bbls. | lb. | .16 — | .16½ |
| Cottonseed oil, crude (f.o.b. mill) | lb. | .10 — | .11 |
| Cottonseed oil, summer yellow | lb. | .13½ — | .13½ |
| Coteonseed oil, winter yellow | lb. | .19 — | ..... |
| Linsed oil, raw, car lots (domestic) | gal. | 1.20 — | ..... |
| Linseed oil, raw, tank cars (domestic) | gal. | 1.30 — | ..... |
| Linseed oil, boiled, car lots (domestic) | gal. | 1.35 — | ..... |

| | | | |
|---|---|---|---|
| Olive oil, commercial | gal. | 3.00 — | 3.10 |
| Palm, Lagos | lb. | .10½ — | |
| Palm, bright red | lb. | .10½ — | |
| Palm, Niger | lb. | .11 — | .12 |
| Peanut oil, crude, tank cars (f.o.b. mill) | lb. | .12½ — | .12½ |
| Peanut oil, refined, in bbls | lb. | .17 — | .18 |
| Rapeseed oil, refined in bbls | gal. | 1.65 — | |
| Rapeseed oil, blown, in bbls | gal. | 1.70 — | |
| Soya bean oil (Manchurian), in bbls N. Y. | lb. | .14 — | .14½ |
| Soya bean oil, tank cars, f.o.b., Pacific coast | lb. | .10½ — | .11 |
| FISH | | | |
| Winter pressed Menhaden | gal. | $0.90 — | $1.05 |
| Yellow bleached Menhaden | gal. | 0.95 — | 1.05 |
| White bleached Menhaden | gal. | 1.00 — | 1.25 |
| Blown Menhaden | gal. | 1.00 — | 1.20 |

## Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

| | | | |
|---|---|---|---|
| Barytes, ground, white, f.o.b. Kings Creek, S. C. | net ton | $22.00 — | 25.00 |
| Barytes, ground, off color, f.o.b. Kings Creek | net ton | 18.00 — | 20.00 |
| Barytes, crude, 88%@94% ba., Kings Creek | net ton | 8.00 — | 10.00 |
| Barytes, ground, white, f.o.b. Cartersville, Ga. | net ton | 23.00 — | 25.00 |
| Barytes, ground, off-color, f.o.b. Cartersville | net ton | 16.00 — | 19.00 |
| Barytes, crude, 88%@94% ba., Cartersville | net ton | 12.00 — | |
| Barytes, floated, f.o.b. St. Louis | net ton | 26.50 — | 28.00 |
| Barytes, crude, min. 98% ba., Missouri | net ton | 11.00 — | 11.25 |
| Blanc fixe, dry | lb. | .05½ — | .06 |
| Blanc fixe, pulp | net ton | 60.00 — | 80.00½ |
| Casein | lb. | .15 — | .18 |
| Chalk, domestic, extra light | lb. | .05 — | .05 |
| Chalk, domestic, light | lb. | .04½ — | .05½ |
| Chalk, domestic, heavy | lb. | .04 — | .05 |
| Chalk, English, extra light | lb. | .05 — | .07 |
| Chalk, English, light | lb. | .05 — | .06 |
| Chalk, English, dense | lb. | .04½ — | .05 |
| China clay, (Kaolin) crude, f.o.b. mines, Georgia | net ton | 9.00 — | 12.00 |
| China clay (Kaolin) washed, f.o.b. Georgia | net ton | 12.00 — | 15.00 |
| China clay (Kaolin) powdered, f.o.b. Georgia | net ton | 18.00 — | 22.00 |
| China clay (Kaolin) crude f.o.b. Virginia points | net ton | 8.00 — | 12.00 |
| China clay (Kaolin) ground, f.o.b. Virginia points | net ton | 15.00 — | 40.00 |
| China clay (Kaolin), imported, lump | net ton | 25.00 — | 35.00 |
| China clay (Kaolin), imported, powdered | net ton | 30.00 — | 60.00 |
| Feldspar, crude, f.o.b. Maryland and North Carolina points | gross ton | 7.50 — | 8.00 |
| Feldspar, crude, f.o.b. Maine | net ton | 7.50 — | 10.00 |
| Feldspar, ground, f.o.b. Maine | net ton | 21.00 — | 23.00 |
| Feldspar, ground, f.o.b. North Carolina | net ton | 17.00 — | 20.00 |
| Feldspar, ground, f.o.b. N. Y. State | net ton | 17.00 — | 20.00 |
| Feldspar, ground, f.o.b. Baltimore | net ton | 30.00 — | |
| Fuller's earth, granular, f.o.b. Fla. | net ton | 25.00 — | |
| Fuller's earth, powdered, f.o.b. Fla. | net ton | 18.00 — | |
| Fuller's earth, imported, powdered | net ton | 35.00 — | 40.00 |
| Graphite (dust polish grade 30%) Ashland, Ala. | lb. | — | .01 |
| Graphite (dust facing grade 50%) Ashland, Ala. | lb. | — | .02 |
| Graphite, crucible, 80% carbon Ashland, Ala. | lb. | — | .05 |
| Graphite, crucible, 90% carbon Ashland, Ala. | lb. | — | 10 |
| Graphite, crucible, 85% carbon | lb. | — | 08 |
| Graphite, crucible, 88% carbon | lb. | — | 09½ |
| Graphite, crucible, 90% carbon | lb. | — | 10½ |
| Pumice stone, imported, lump | lb. | .04 — | .50 |
| Pumice stone, domestic, lump | lb. | .05 — | |
| Pumice stone, ground | lb. | .04 — | .07 |
| Quartz (acid tower) fist to head, f.o.b. Baltimore | net ton | — | 10.00 |
| Quartz (acid tower) 1½@2 in., f.o.b. Baltimore | net ton | — | 14.00 |
| Quartz (acid tower) rice, f.o.b. Baltimore | net ton | — | 17.00 |
| Quartz, lump, f.o.b. North Carolina | net ton | 5.00 — | 7.50 |
| Shellac, orange fine | lb. | 1.45 — | 1.50 |
| Shellac, orange superfine | lb. | 1.55 — | |
| Shellac, A. C. garnet | lb. | 1.05 — | 1.15 |
| Shellac, T. N. | lb. | 1.20 — | 1.30 |
| Soapstone | ton | 15.00 — | 25.00 |
| Talc, paper-making grades, f.o.b. Vermont | ton | 10.00 — | 20.00 |
| Talc, roofing grades, f.o.b. Vermont | ton | 9.00 — | 15.00 |
| Talc, rubber grades, f.o.b. Vermont | ton | 10.00 — | 15.00 |
| Talc, powdered, Southern, f.o.b. cars | ton | 20.00 — | 25.00 |
| Talc, imported | ton | 60.00 — | 70.00 |
| Talc, California Talcum Powder grade | ton | 20.00 — | 35.00 |

## Refractories

| | | |
|---|---|---|
| Chrome brick, f.o.b. Chester, Pa., carlots | net ton | 90– 100 |
| Chrome brick, 9-in. strs. and sizes, f.o.b. Baltimore | net ton | 90– 95 |
| Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works | 1,000 | 50– 55 |
| Fire clay brick, 1st quality, f.o.b. St. Louis | 1,000 | 45– |
| Fire clay brick, 1st quality, f.o.b. New Jersey | 1,000 | 75– |
| Fire clay brick, 2d quality, 9-in. shapes f.o.b. Pennsylvania, Ohio and Kentucky works | 1,000 | 45– 55 |
| Magnesite brick, 9 in. straights, f.o.b. Baltimore | net ton | 100 110 |
| Magnesite brick, 9-in. sizes and shapes larger than 9-in. | | Regular extras |
| Magnesite brick, f.o.b. Chester | net ton | 90– 100 |
| Silica brick, 9-in. and 9-in. sizes, Chicago district | 1,000 | 55– |
| Silica brick, f.o.b. Birmingham | 1,000 | 51– 55 |
| Silica brick, f.o.b. Mt. Union, Pa. | 1,000 | 55– 60 |

## Ferro-Alloys

All f.o.b. Works

| | | | |
|---|---|---|---|
| Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y. | net ton | $200.00 — | $250.000 |
| Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots | lb. | 17 — | 18 |
| Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots | lb. | 19 — | 20 |
| Ferro-manganese, 76-80% Mn, domestic | gross ton | 200.00 — | 225.00 |
| Ferro-manganese, 76-80% Mn, English | gross ton | 195.00 — | 220.00 |
| Spiegeleisen, 18-22% Mn | gross ton | 75.00 — | |
| Ferro-molybdenum, 50-60% Mo, per lb. of Mo. | lb. | 2.25 — | 2.75 |
| Ferro-silicon, 10-15% | gross ton | 60.00 — | 65.00 |
| Ferro-silicon, 50% | gross ton | 80.00 — | 90.00 |
| Ferro-silicon, 75% | gross ton | 150.00 — | 160.00 |
| Ferro-tungsten, 70-80%, per lb. of contained W. | lb. | 1.10 — | 1.15 |
| Ferro-uranium, 35-50% of U, per lb. of U content | lb. | 7.00 — | |
| Ferro-vanadium, 30-40% per lb. of contained V. | lb. | 6.50 — | 7.75 |

## Ores and Semi-finished Products

All f.o.b. Mines, Unless Otherwise Stated

| | | | |
|---|---|---|---|
| Chrome ore, Calif. concentrates, 50% min. $Cr_2O_3$ | unit | .60 | .65 |
| Chrome ore, 40%, min., $Cr_2O_3$ f.o.b. Atlantic Seaboard | unit | .77 — | .85 |
| *Coke, foundry, f.o.b. ovens | net ton | 18.50 — | 20.00 |
| *Coke, furnace, f.o.b. ovens | net ton | 18.00 — | 19.00 |
| *Coke, petroleum, refinery, Atlantic Seaboard | net ton | 24.00 | |
| Fluor spar, lump, f.o.b. Tonuco, New Mexico | net ton | 17.50 — | |
| Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines | net ton | 25.00 — | 27.50 |
| Ilmenite, 52% $TiO_2$, per lb. ore | lb. | .01½ — | .02 |
| Manganese Ore, 50% Mn, c.i.f. Atlantic seaport | unit | .70 — | .80 |
| Manganese ore, chemical ($MnO_2$) | gross ton | 75.00 — | 85.00 |
| Molybdenite, 85% $MoS_2$, per lb. of $MoS_2$, N. Y. | lb. | .75 — | .85 |
| Monazite, per unit of $ThO_2$ | unit | 42.00 — | |
| Pyrites, Spanish, fines, c.i.f., Atlantic seaport | unit | .12 — | |
| Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport | unit | .16½ — | |
| Pyrites, Spanish, run of mines, ci.f., Atlantic seaport | unit | .12 — | .14 |
| Pyrites, domestic, fines | unit | .12 — | .14 |
| Rutile, 95% $TiO_2$ per lb. ore | lb. | .15 — | |
| Tungsten, Scheelite, 60% $WO_3$ and over, per unit of $WO_3$ | unit | 7.00 — | |
| Tungsten, Wolframite, 60% $WO_3$ and over, per unit of $WO_3$, N. Y. C. | unit | 6.00 — | 7.00 |
| Uranium Ore (Carnotite) per lb. of $U_3O_8$ | lb. | 2.75 — | 3.00 |
| Uranium oxide, 96% per lb. contained $U_3O_8$ | lb. | 2.75 — | 3.00 |
| Vanadium pentoxide, 99% | lb. | 12.00 — | 14.00 |
| Vanadium Ore, per lb. of $V_2O_5$ contained | lb. | 1.25 — | |
| Zircon, washed, iron free | lb. | .10 — | |

*Nominal

## Non-Ferrous Metals

New York Markets

| | Cents per Lb. |
|---|---|
| Copper, electrolytic | 19.00 |
| Aluminum, 98 to 99 per cent. | 33.00 |
| Antimony, wholesale lots, Chinese and Japanese | 8.00 |
| Nickel, ordinary (Ingot) | 43.00 |
| Nickel, electrolytic | 45.00 |
| Tin, Straits, spot | 48.50 |
| Lead, New York, spot | 9.25 |
| Lead, E. St. Louis, spot | 8.90 |
| Zinc, spot, New York | 8.25 |
| Zinc, spot, E. St. Louis | 7.90@8.40 |

OTHER METALS

| | | |
|---|---|---|
| Silver (Commercial) | oz. | $0.99½ |
| Cadmium | lb. | 1.40@1.50 |
| Bismuth (500 lb. lots) | lb. | 2.70 |
| Cobalt | lb. | 2.50@3.00 |
| Magnesium (f.o.b. Niagara Falls) | lb. | 1.75 |
| Platinum | oz. | 95@105 |
| Iridium | oz. | 350.00 |
| Palladium | oz. | 100.00 |
| Mercury | 75 lb. | 88.00@90.00 |

FINISHED METAL PRODUCTS

| | Warehouse Price Cents per Lb. |
|---|---|
| Copper sheets, hot rolled | 33.50 |
| Copper bottoms | 38.00 |
| Copper rods | 38.00@40.00 |
| High brass wire and sheets | 30.25 |
| High brass rods | 27.00 |
| Low brass wire and sheets | 28.50 |
| Low brass rods | 29.00 |
| Brazed brass tubing | 38.25 |
| Brazed bronze tubing | 41.75 |
| Seamless copper tubing | 34.00 |
| Seamless high brass tubing | 33.00 |

SCRAP METALS

| | Cents per Lb. Buying Price |
|---|---|
| Aluminum, cast scrap | 23.00@23.50 |
| Aluminum, sheet scrap | 23.00@23.50 |
| Copper, heavy machinery comp | 14.50@15.00 |
| Copper, heavy and wire | 15.25@15.75 |
| Copper, light and bottoms | 13.00 |
| Copper, heavy cut and crucible | 16.25 |
| Brass, heavy | 9.50@10.00 |
| Brass, light | 7.25@7.75 |
| No. 1 clean brass turnings | 9.00@9.50 |
| No. 1 comp. turnings | 12.50@13.50 |
| Lead, tea | 4.75@5.00 |
| Lead, heavy | 7.25@7.50 |
| Zinc, scrap | 5.25 |

## Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

| | New York | | | Cleveland | | Chicago | |
|---|---|---|---|---|---|---|---|
| | Current | One Month Ago | One Year Ago | Current | One Year Ago | Current | One Year Ago |
| Structural shapes | $4.47 | $3.97 | $3.47 | $5.00 | $3.37 | $3.97 | $3.47 |
| Soft steel bars | 4.47 | 4.12 | 3.37 | 4.50 | 3.27 | 3.87 | 3.37 |
| Soft steel bar shapes | 4.47 | 4.12 | 3.37 | | 3.27 | 3.87 | 3.37 |
| Soft steel bands | 6.32 | 5.32 | 4.07 | 6.25 | | | |
| Plates, ¼ to 1 in. thick | 4.67 | 4.17 | 3.67 | 4.50 | 3.57 | 4.17 | 3.67 |

# Industrial

Financial, Construction and Manufacturers' News

## Construction and Operation

### California

ATASCADERO—The Bd. Educ. will receive bids about Oct. 1 for the construction of three 1- and 2-story buildings. A chemical laboratory will be installed in same. Estimated cost, $200,000. J. T. Roth, bldg. comr.

### Connecticut

HARTFORD—The Frasse Steel Corp., 45 Boulevard St., has awarded the contract for the construction of a 1-story, 35x105-ft. manufacturing addition, to J. H. Grozier Co., 721 Main St. Estimated cost, $25,000.

NAUGATUCK—The Naugatuck Chemical Co., Elm St., has awarded the contract for the construction of a 2-story, 50x60-ft. manufacturing building, to the Flynt Bldg. & Constr. Co., 356 Main St., Palmer, Mass. Estimated cost, $60,000. Noted July 21.

NEW HAVEN—The Fritzell Brass Fdry. Co., 33 Chestnut St., plans to remodel the manufacturing plant on Middletown Ave. Fletcher Thompson, Inc. 1089 Broad St., Bridgeport, archt. and engr.

### Florida

PALATKA—W. A. McGuire of the McGuire Phosphate & Fertilizer Co. plans to build an acid chamber, etc. Estimated cost, $1,000,000.

### Iowa

BANCROFT—The city has awarded the contract for the construction of a sewage disposal plant, to H. R. Ash.

DOON—The city has awarded the contract for a sewage disposal plant, to Ward & Weighton, Sioux City. Estimated cost, $14,634.

OLLIE—The School Bd. will receive bids until Sept. 3 for the construction of a 2-story, 58x98-ft. school. General chemical and physical laboratories will be installed in same. Estimated cost, $100,000. J. D. Ridgeway, secy. W. E. Hulse & Co., 309 Securities Bldg., Des Moines, archt.

### Massachusetts

BOSTON — Gay & Proctor, archts., 50 Bromfield St., will soon award the contract for the construction of a 4-story, 40x61-ft. laboratory for the Women's Educational and Industrial Union, 264 Boylston St.

### Minnesota

AUSTIN—The Bd. Educ. plans to build a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, $500,000. J. E. Crippen, secy.

JANESVILLE — The city has awarded the contract for the construction of a sewerage system and sewage disposal plant, to the Bisballe Constr. Co., Tyler. Estimated cost, $104,000.

### New Jersey

TRENTON—The Hamilton Rubber Mfg. Co., Mead St., has awarded the contract for the construction of a 2-story, 20x40-ft. factory addition, to Karno-Smith Co., Broad St. Bank. Estimated cost, $15,000.

PAULSBORO—I. P. Thomas & Son Co. has awarded the contract for the construction of a 1-story, 80x220-ft. fertilizer plant, to the Austin Co., Bulletin Bldg., Philadelphia, Pa.

### Ohio

AKRON — The United Machine & Mfg. Co. had preliminary plans prepared for the construction of a 100x200-ft. foundry addition. Estimated cost, $100,000. L. E. Griffith, pres.

ALLIANCE—The Alliance Fertilizer Co. is building a 100x200-ft. steel addition to its present plant.

CLEVELAND — The Amer. Turpentine Co., 136 Engineers Bldg., plans to build a 1- and 3-story, 100x180-ft. factory and a 24x40-ft. boiler house along the tracks of the Beltline Ry., here. Estimated cost, $200,000. H. D. Tremmel, secy.

CLEVELAND—The city plans to build a 3-story hospital on Scranton Rd. A chemical laboratory will be installed in same. Estimated cost, $3,500,000. A. B. Sprosty, Dir. of Pub. Safety, City Hall. S. S. Goldwater, New York City, consult. archt.

CLEVELAND — The Cleveland Wrought Products Co., 3590 West 58th St., has awarded the contract for the construction of a 1-story, 56x145-ft. factory, to the Hebing Co., 1832 West 54th St. Estimated cost, $50,000.

CLEVELAND — The Cuyahoga Sheet Metal Co., 7908 Quincy Ave., has awarded the contract for the construction of a 1-story, 34x60-ft. factory, to Paul De Lorenzo, 303 Pen Sq. Bldg. Estimated cost, $12,000.

CLEVELAND—The Ohio Bronze Powder Co., 1120 East 152d St. plans to build a 2-story factory. Estimated cost, $50,000. G. F. Glass, pres.

COLUMBUS—The Federal Chemical Co., 1200 Bon Law Ave., has awarded the contract for the construction of a 122x167-ft. addition to fertilizer factory, to the Chemical Constr. Co., Charlotte, N. C. Estimated cost, about $100,000.

EATON—The Bd. of Pub. Affairs received bid for the construction of a filtration plant, etc., from Burgess & Nitle, Columbus, $24,000. Noted May 26.

PAYNE — Robinette, Bruyere, Cameron, archts., Spitzer Bldg., Toledo, will receive bids about Sept. 2 for the construction of a 2-story, 80x140-ft. school for the Payne Bldg. Bd. Chemical laboratory equipment will be installed in same. Estimated cost, $100,000.

### Pennsylvania

NEW CASTLE — The Johnson Bronze Co., South Mill St., will soon award the contract for the construction of a 68x101-ft. foundry, etc. Estimated cost, $125,000. Frank D. Chase, 645 North Michigan Ave., Chicago, Ill., archt.

### Wisconsin

CAMPBELLSPORT — The White House Milk Products Co., West Bend, is having plans prepared for the construction of a 1-story, 50x100-ft. condensed milk plant. M. Tullgren & Sons, 425 East Water St., Milwaukee, archts.

MILWAUKEE — The C. Hennecke Co., 1353 North Pierce St., plans to build a 1-story steel fabricating plant on Port Washington Rd.

MILWAUKEE—S. F. Kadow, archt., 97 Wisconsin St., will soon award the contract for the construction of a 1-story, 30x145-ft. foundry addition on Park St., for the A. E. Martin Fdry. & Machine Co., 705 Park St.

MILWAUKEE — The Marquette University, 1115 Grand Ave., is having preliminary plans prepared for a several story dental school on Grand Ave. Chemical laboratories will be installed in same. Estimated cost, $750,000. Kirchhoff & Rose, Majestic Bldg., archts.

NORTH MILWAUKEE (Milwaukee P. O.)—The Bernert Mfg. Co., 489 12th St., Milwaukee has awarded the contract for the construction of a 1-story, 60x120-ft. foundry, to E. Grether, 1121 2d St., Milwaukee. Estimated cost, $40,000. Noted May 26.

SHEBOYGAN — The Columbus Rubber Wks., c/o Leo Hofmeister, 176 16th St., Milwaukee, is having plans prepared for the construction of additions to factory. Estimated cost, $100,000. Juul & Smith, archts. Noted Aug. 4.

SHEBOYGAN — The Sheboygan Clinic Association is having preliminary plans prepared for the construction of a 3-story, 65x200-ft. clinic building. A laboratory and X-ray will be installed in same. Estimated cost, $100,000. W. Gunther, 902 North 8th St., pres.

### British Columbia

TRAIL — The Consolidated Mining & Smelting Co. of Canada is building additions to its copper plant, including a rod mill, etc., here.

### Ontario

LAKEFIELD—The Canada Cement Co., 9 Herald Bldg., Montreal, plans to reopen its cement works here and spend $500,000 in additions, alterations, repairs and new equipment.

TORONTO — The city plans to build a waterworks plant in the eastern section of the city. Plans include intakes, pumphouse, filters, etc. Estimated cost, $8,000,000. R. C. Harris, engr.

## Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its 1920 meeting Dec. 27, 1920, to Jan. 1, 1921, at Chicago, Illinois.

AMERICAN CERAMIC SOCIETY will hold its summer meeting at the La Salle Hotel in Chicago, Aug. 16, 17 and 18.

AMERICAN CHEMICAL SOCIETY will hold its fall meeting in Chicago, Sept. 7 to 10 inclusive.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in the Hotel Statler, Cleveland, Ohio, Sept. 30, Oct. 1 and 2.

AMERICAN FOUNDRYMEN'S ASSOCIATION will meet in Columbus, Ohio, Oct. 4 to 8 inclusive.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its one hundred and twenty-second meeting Aug. 20, to Sept. 3, at Lake Superior.

AMERICAN MINING CONGRESS will hold its next convention in Denver Nov. 15.

AMERICAN PEAT SOCIETY will hold its annual meeting at Madison, Wis., Sept. 2, 3 and 4, 1920.

AMERICAN PHYSICAL SOCIETY will hold a meeting Nov. 27 at the Case School of Applied Science, Cleveland, and the annual meeting, beginning Dec. 28, at Chicago, the latter being the occasion of the special quadrennial meeting of the American Association for the Advancement of Science and the Affiliated Societies.

AMERICAN STEEL TREATERS' SOCIETY, Chicago, will hold its second annual convention and exhibit, combined with the convention of the Steel Treating Research Society of Detroit, Mich., in the Coliseum Museum, Philadelphia, Pa., Sept. 14 to 18 inclusive.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS will hold its 14th annual convention at the Hotel Pennsylvania, New York City, Sept. 20 to 24, 1920.

ENGINEERING COUNCIL will hold its next meeting in Chicago Thursday, Oct. 21, 1920.

INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

IRON AND STEEL INSTITUTE (Brit'sh) will hold its autumn meeting at Cardiff by invitation of the Ironmasters and Steel Manufacturers of South Wales and Monmouthshire. The date of the meeting will be Tuesday, Sept. 21, for the assembling of the members at Cardiff, and the formal proceedings will open on the morning of Wednesday, Sept. 22.

NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SIXTH) will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall national convention at Carnegie Music Hall, Pittsburgh, Pa., Nov. 10, 11 and 12, 1920.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall meeting at Saratoga Springs, N. Y., Sept. 1, 2 and 3.

# Manufacturers' Catalogs

THE LAKEWOOD ENGINEERING CO., Cleveland, O., announces that the Lakewood tier-lift truck's application to a number of kinds of work, and the mechanical features of the truck, are described in a new 32-page tier-lift bulletin. Copies will be sent on request.

THE CHEMICAL EQUIPMENT CO., Chicago, Ill., has issued a new catalog describing spray systems, valves, centrifugal pumps, priming systems, and vacuum evaporators. The latter item is a new evaporator recently designed by the company. The equipment contains new charts with operation figures and various properties of dry air, saturated air and steam, outlined in tables.

CHICAGO PNEUMATIC TOOL CO., New York, has recently issued Bull. No. 504, describing its slogger rock drill. Copies are now available, upon request, from the New York office or branches.

THE BUFFALO FORGE CO., Buffalo, N. Y., has just issued three bulletins. "Niagara Conoidal Fans" is the title of Cat. 421, which contains in 52 pages tables of performances of conoidal fans that will enable engineers and architects to make fan selections to meet any demands in ordinary heating and ventilating practice, together with illustrations and descriptions of the different kinds. Cat. 721 is on "Buffalo Dyehouse and Bleachery Ventilation." Seven illustrations are given, taken at one-minute intervals from the time the ventilating apparatus was started with the room foggy until the room was free from all fog. Other interesting illustrations are given of plants where the Buffalo dyehouse and bleachery ventilation is installed and the apparatus used. "Buffalo Fan System of Heating, Ventilating and Humidifying" is the title of Cat. 700, which is practically a handbook on heating and ventilating inasmuch as it is taken to a great extent from the company's "Handbook on Heating and Ventilating." This attractive booklet has 116 pages and gives illustrations as well as descriptive matter and charts.

THE WILL CORP., Rochester, N. Y., has issued a catalog on "Water Stills" which gives in a straightforward manner information on water stills so that a selection may be made according to capacity, construction and type best suited for the production of distilled water for laboratory, technical and domestic uses in places which are gas, steam and electrically operated.

THE CUTLER-HAMMER MFG. CO., Milwaukee, Wis., has issued two new catalogs. "Machine Tool Control, C-H Controllers," is the title of a 48-page book known as publication 845. The preface states that the recent changes in manufacturing conditions make it essential to provide better equipment than formerly, easier means of operating and more accurate and convenient control, and explains how these conditions can be fulfilled by C-H controllers. "C-H Lifting Magnets" is the title of the other catalog, known as publication 855. It tells how many iron foundries, steel mills, shipyards and other plants are speeding up production, wiping out demurrage charges, reducing handling costs and solving the labor problem by the use of these magnets for handling pig iron, scrap, castings, rails, etc.

THE RAYMOND IMPACT PULVERIZER CO., Chicago, Ill., calls attention to Cat. No. 14, on "Grinding, Pulverizing and Air Separating Machinery." This 62-page booklet gives information and illustrations of accessories, installation drawings, installation photographs, automatic pulverizers, roller mills and separating plants.

THE FANSTEEL PRODUCTS CO., of North Chicago, Ill., has issued a new loose-leaf handbook dealing with the company's products, with special reference to the properties of tungsten and molybdenum, for the information of users of these metals in the electrical and chemical industries. The sheets are of a size to fit the ordinary engineer's loose-leaf pocket book. Additional sheets from the research laboratory of the company will be issued from time to time to those on the mailing list. Any user or prospective user of these metals may have his name put on the mailing list by applying to the Fansteel Products Co., North Chicago, Ill.

THE WELLMAN-SEAVER-MORGAN CO. of Cleveland, O., has recently issued a series of bulletins showing some of the notable installations made by the company listed as follows: Bulletin 41, Coal and Ore Handling Machinery; Bulletin 42, Special Cranes; Bulletin 43, Hydraulic Turbines; Bulletin 44, Hoisting and Mining Machinery; Bulletin 45, Steel Works Equipment; Bulletin 46, Coke Oven Machinery; Bulletin 47, Port and Terminal Equipment; Bulletin 48, Rubber Machinery. The scheme of each of these bulletins is to show on facing pages a picture of the particular installation and a working blueprint of each machine.

THE KOPPERS CO., Pittsburgh, Pa., has published a booklet on "Recent Developments in By-Product Coke Oven Engineering," by Joseph Becker and F. W. Sperr, Jr. This booklet discusses certain developments of major importance, rather than the enumeration of various improvements in detail, made especially during the past five years. Many interesting illustrations are given.

J. G. WHITE ENGINEERING CORP., 43 Exchange Place, New York City, is issuing a folder, "Industrial Building at Matagorda." It gives information about, and illustrations of the power plant, warehouse, machine shop, and model homes erected for the housing of workmen, at the sulphur plant of the Texas Gulf Sulphur Co., Matagorda, Texas.

VIELE, BLACKWELL & BUCK, 49 Wall Street, New York, has just issued two new bulletins. Bull. No. 8 entitled "Tin and Terne Plate" has been published in an endeavor to give foreign traders full particulars on a commodity which, due to its many classifications into sizes, grades, packings, price extras and differentials, has oftentimes been the subject of misunderstanding. Bull. No. 9, entitled "Hydro-Electric and Steam Power Plants," gives illustrations which show some of the engineering and construction work done by this company.

# New Publications

"SCIENCE IN INDUSTRY" is the title of a booklet issued recently by M. H. Avram & Co., New York City, in which is pointed out the need of a systematic method of scientific guidance and control, the application of which would tend to decrease industrial waste and strengthen industrial effectiveness in all enterprises making use of it.

CANADA DEPARTMENT OF MINES, Ottawa, has issued a booklet, No. 511, "On Graphite," by Hugh S. Spence.

MAGNESIA ASSOCIATION OF AMERICA, Philadelphia, Pa., has issued a booklet on "Specification AA for '85 per cent Magnesia' Non-Heat-Conducting Coverings for Power and Heating Systems," which has been compiled and indorsed by the Mellon Institute of Industrial Research, University of Pittsburgh, and adopted by the Magnesia Association of America, Jan. 23, 1920.

"THE TECHNICAL BOOK REVIEW INDEX" is a quarterly publication issued by the Technology Department of the Carnegie Library of Pittsburgh. It records brief extracts of scientific and technical book reviews from the journals received at the library and is the only publication devoted exclusively to this purpose. The price of the index is 50c. per year.

"SUPPORTING STRENGTH OF DRAIN TILE AND SEWER PIPE UNDER DIFFERENT PIPE-LAYING CONDITIONS," by W. J. Schlick, is Bull. 57, issued by the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa.

"PRINCIPLES OF CYLINDRICAL GRINDING," by Charles H. Norton, with an appendix, "On Grain Depth of Cut," by George I. Alden, has been issued by the Norton Co., Worcester, Mass.

"ALCOHOL: ITS POSITION IN PHARMACY AND INDUSTRY," which is the address of William C. Crounze before the annual convention of the American Pharmaceutical Association, held at Washington, D. C., May 8, 1920, has been issued in pamphlet form.

"THE MAGNETITE DEPOSITS OF THE EASTERN MESABI RANGE, MINNESOTA," by Frank F. Grout and T. M. Broderick, is Bull. No. 17, issued by the University of Minnesota, Minnesota Geological Survey, Minneapolis, Minn.

"POSSIBILITIES OF POTTERY MANUFACTURE FROM IOWA CLAYS," by W. G. Whitford and O. J. Whittemore, is Bull. 58, issued by the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa.

"THE ELECTRIC FURNACE AS APPLIED TO METALLURGY," bibliographic series No. 4, published by Arthur D. Little, Inc., Cambridge, Mass., is reprinted from a paper presented by Clarence Jay West before the American Electrochemical Society, April 8, 1920.

"ELECTROMETALLURGICAL AND ELECTROCHEMICAL INDUSTRY IN THE STATE OF WASHINGTON," by Charles Denham Grier, is Bull. No. 5, published by the Engineering Experiment Station, University of Washington, Seattle, Wash.

NEW U. S. GEOLOGICAL SURVEY PUBLICATIONS: I:1, Cadmium in 1919, by C. E. Siebenthal (Mineral Resources of the U. S., 1919, Part I), published June 18, 1920; I: 20, Iron Ore, Pig Iron and Steel in 1918, by Ernest F. Burchard (Mineral Resources of the U. S., 1918, Part I), published April 20, 1920; I: 22, Manganese and Manganiferous Ores in 1918, by D. F. Hewett (Mineral Resources of the U. S., 1918, Part I), published April 10, 1920; I: 23, Chromite in 1918, by J. S. Diller, with papers on Foreign Deposits of Chromite, by E. F. Bliss and H. R. Aldrich, and on Chromite and Chromiferous Iron Ore in Cuba, by E. F. Burchard (Mineral Resources of the U. S., 1918, Part I), published May 15, 1920; I: 25, Copper in 1917, by R. S. Butler (Mineral Resources of the U. S., 1917, Part I), published Mar. 13, 1920; I: 27, Zinc in 1917, by C. E. Siebenthal (Mineral Resources of the U. S., 1917, Part I), published April 6, 1920; I: 28, Lead in 1917, General Report, by C. E. Siebenthal (Mineral Resources of the U. S., 1917, Part I), published May 8, 1920; II: 26, Mica in 1918, by Waldemar T. Schaller (Mineral Resources of the U. S., 1918, Part II), published May 24, 1920; II: 27, Coal in 1918, Part A—Production, by C. E. Lesher (Mineral Resources of the U. S., 1918, Part II), published May 28, 1920; II: 30, Feldspar in 1918, by L. M. Beach (Mineral Resources of the U. S., 1918, Part II), published June 28, 1920; II: 31, Barytes and Barium Products in 1918, by George W. Stose (Mineral Resources of the U. S., 1918, Part II), published June 28, 1920.

U. S. BUREAU OF MINES PUBLICATIONS: Bull. 112, Mining and Preparing Domestic Graphite for Crucible Use, by George D. Dub and Frederick G. Moses, with a chapter on methods of analysis used by the Bureau of Mines, by G. B. Taylor and W. A. Selvig; Bull. 173, Manganese, Uses, Preparation, Mining Costs and the Production of Ferro-Alloys, by C. M. Weld and others; Bull. 196, Coal-Mine Fatalities in the United States, 1919, and coal-mine statistics supplementing those published in Bull. 115, by Albert H. Fay, with a list of permissible explosives, lamps and motors, tested prior to Jan. 31, 1920; Tech. Paper 229, Accident Prevention in the Mines of Butte, Mont., by Daniel Harrington; Tech. Paper 243, Development of Liquid Oxygen Explosives During the War, by George S. Rice; Tech. Paper 247, Perforated Casing and Screen Pipe in Oil Wells, by E. W. Wagy.

NEW BUREAU OF STANDARDS PUBLICATIONS: No. 95, Inks—Their Composition, Manufacture, and Methods of Testing; Tech. Paper 163, Stresses Caused by Cold-Rolling, by Henry M. Howe and Edward C. Groesbeck.

# Industrial Notes

THE COMMERCIAL LABORATORIES, W. D. McAbee, director, announces a change of address from 909 Majestic Bldg. to 357 Transportation Bldg., Indianapolis, Ind.

THE CELITE PRODUCTS CO., New York City, announces the appointment of Charles J. Parsons on the sales staff in New York City. Mr. Parsons is a specialist in power plant work and is a graduate of the Massachusetts Institute of Technology.

LEA-COURTENAY CO., manufacturer of centrifugal pumping machinery, announces the opening of its New York City office at 2 Rector St.

THE OXWELD ACETYLENE CO. of Newark, N. J., Chicago and San Francisco is proud of the distinguished service award tendered the company by the War Department of the United States. The award reads: "The War Department of the United States recognizes in this award for distinguished service the loyalty, energy and efficiency in the performance of the war work by which the Oxweld Acetylene Co. aided materially in obtaining victory for the arms of the United States of America in the war with the Imperial German Government and the Royal Austro-Hungarian Government." The award is signed by the Secretary of War and the Assistant Secretary of War, Director of Munitions.